AMATEUR RADIO 73

ACE

January 1969

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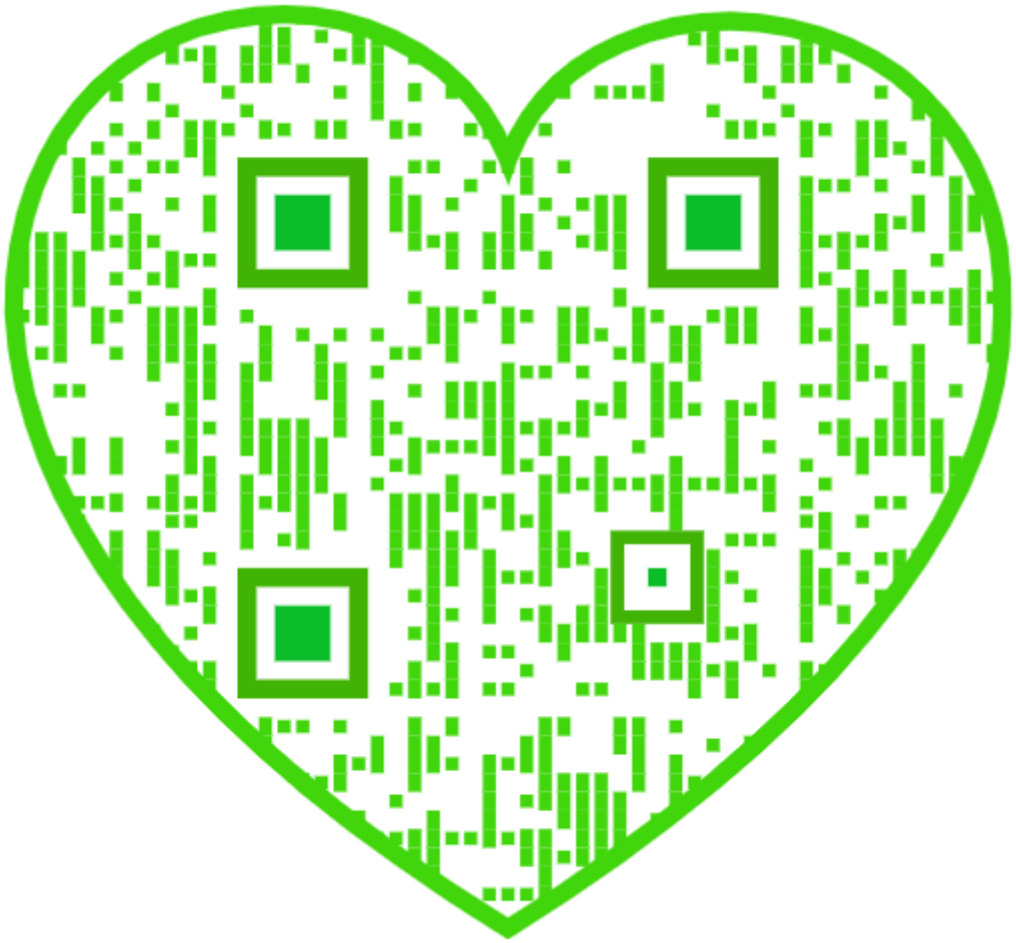

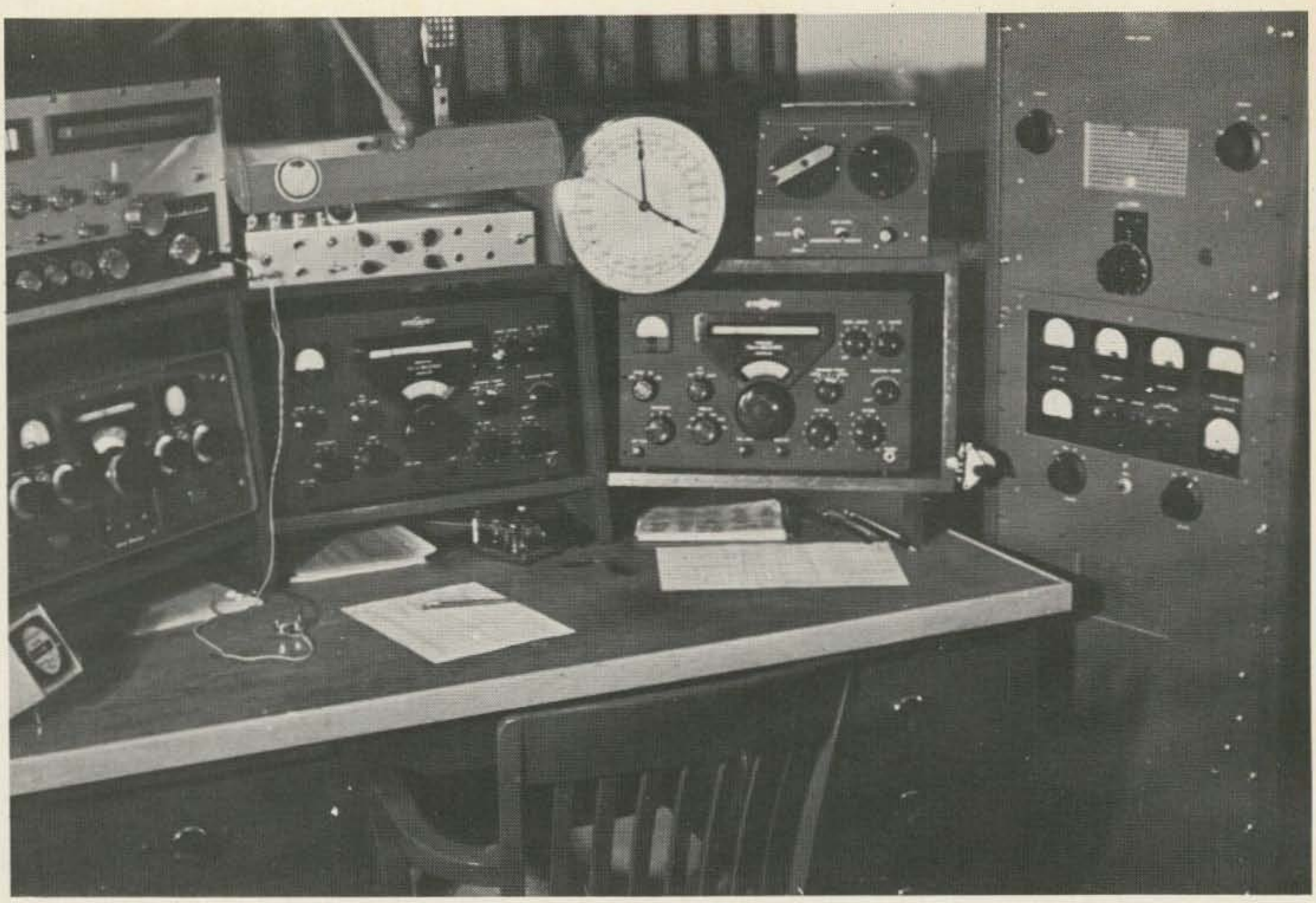

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73 MAGAZINE

January 1969
Vol. LXIX No. 1

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Editor

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Cover Photo: Clarence Synder W3PYF has superbly stated the need for CW for the Amateur Extra License.
December's cover did not have full credits. The equipment shown is as follows: Amphenol Model 870 Millivolt Commander, McCoy 9 MHz filter and crystals, a variety of Amphenol connectors. The dog and Santa were constructed almost entirely of Amphenol connectors and sockets by John Gove. The Transceivers are readily identified.

Editorial Statement: Any errors found in this magazine are put there deliberately. We try to publish something for everyone and some people merely read the magazine to find errors.

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Editorial Liberties

RED FACE DEPARTMENT

Apologies To. R. L. Drake

The December issue of 73 contained a review of transceivers. This was compiled by the *former* Technical Editor.

The review contained an item he called the Drake TR-4B. The source of his information remains a mystery. There ain't no such animal.

Drake has been swamped with calls, cancelled orders, and irate recent buyers who feel they have been cheated. I have Excedrin Headache #1.

Apparently part of the problem arose with his confusing the TR44B and the TR4. The TR44B combines the T-4B transmitter and the R-4B receiver in one cotnsole. The TR-4 is a transceiver and should have been the only one reviewed. Photos of both units are shown below.

Sorry about that Bob and Peter.

. . . Kayla W1EMV

The Drake TR-44B

The Drake TR-4

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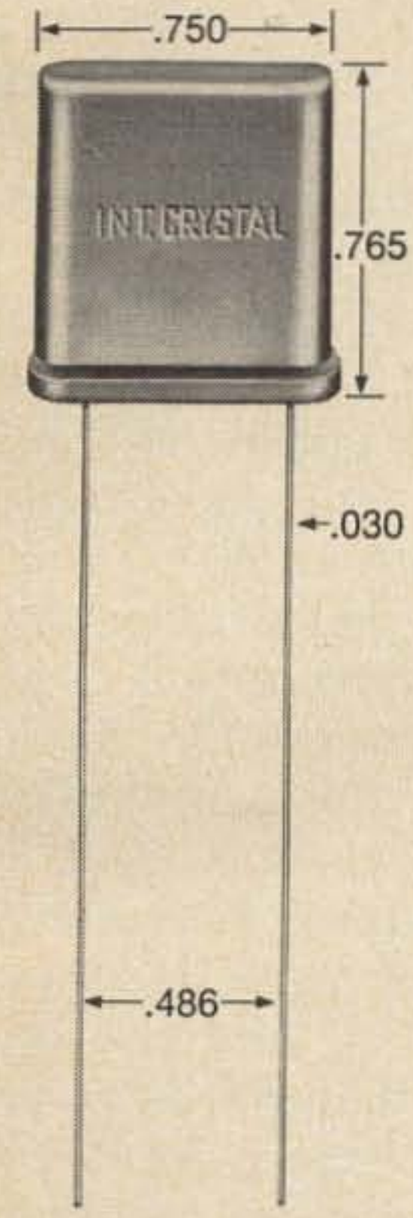

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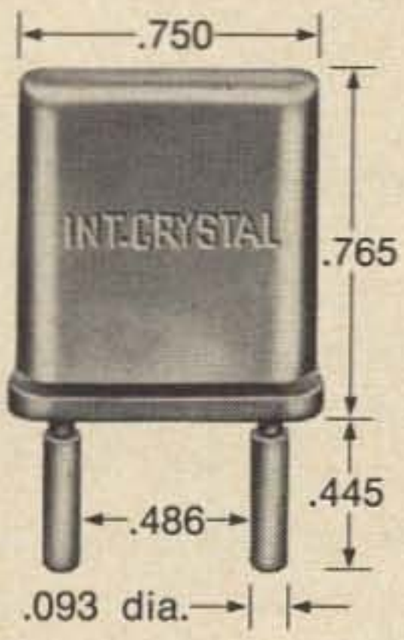

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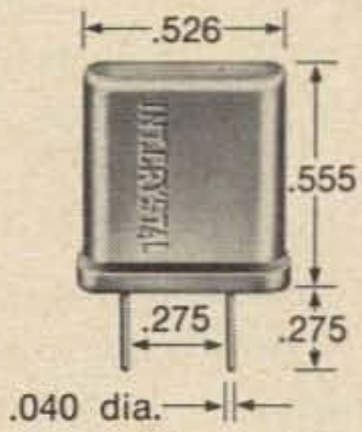

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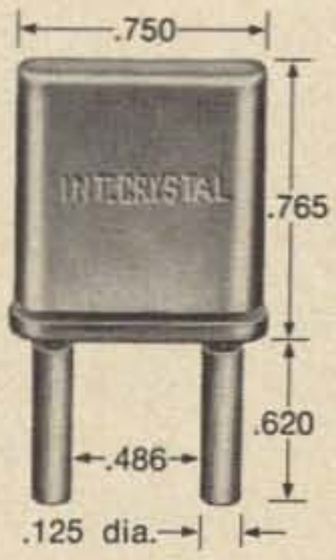

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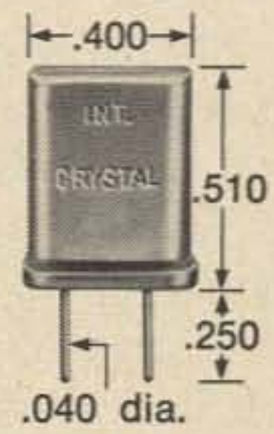

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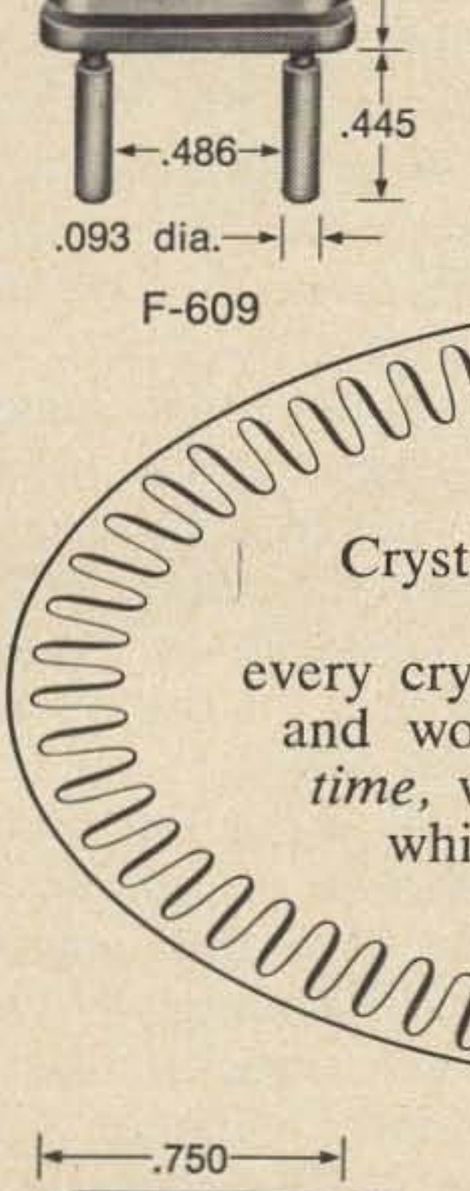

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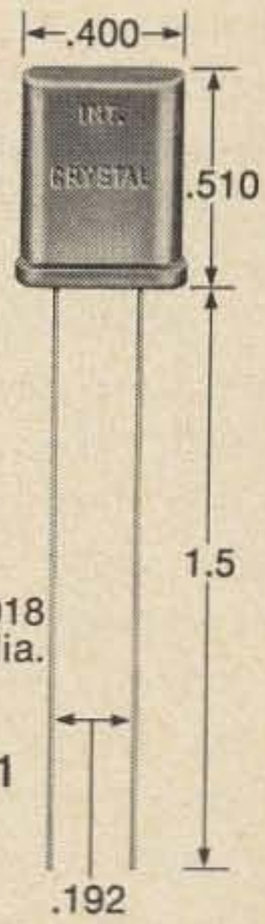

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de W2NSD/1

The other day an amateur stopped by for a short visit to 73 headquarters and mentioned that he had been conducting an investigation of our bands and had discovered that many of the contacts that were going on seemed to be rather pointless. Frankly I have to admit that this is not the first time that I've heard rumors about this.

When something like this develops to the point where we become aware of it here at 73 we like to see what we can do to correct it before it turns into a trend and the ARRL requests the FCC to legislate against it.

The first step, obviously, was to conduct a survey and try to find out the extent of the incipient trouble. The entire 73 staff was pressed into service on an intensive investigation of our bands. I am happy to report that our figures show that only about 98.7% of the contacts on the amateur bands are dull and boring both to the participants and the non-participating listeners. This was an encouraging discovery since first estimates had placed the figure somewhere over 99.3%.

A well known amateur psychiatrist was consulted and he pointed out that even though the contacts are obviously almost totally without content that they fulfill a basic need to communicate and thus do serve to satisfy a subconscious need. He went on to say that the vacuity of the contacts seems to eventually become evident to the participants on some level of awareness and that this has a strong tendency to decrease their activity, eventually terminating their amateur activities completely. After a few years of freedom from the deadening dullness of the average radio contacts many amateurs, driven by the subconscious need to communicate, find themselves getting back into their old hobby. The pattern repeats itself.

Pressed for some explanation for the dullness of contacts, our psychiatrist friend revealed that this results from a common but little-noticed phenomenon: mike fright. In the case of the CW operator it might be called key fright. It is a manifestation of the broadcast radio obsession against having any dead air. The operator is so afraid that he will not be able to think of something to talk about that he is actually unable to think of something to talk about. To fill in the time he does the obvious thing, he recites a list of the equipment that he is using and discusses the weather. Then, with a great sigh of relief, he turns it over to the other fellow. The other chap does exactly the same, leaving operator number one with nothing whatever to comment on and the prospect of either sitting there with his transmitter on trying to think of something to talk about or else asking for a QSL and signing off.

The pattern, which apparently had its roots in the early days of amateur radio, may just possibly be broken. Perhaps it is worth a try. Actually the difficulty isn't all that different from the everyday efforts we make to communicate with people in our business and family worlds. Cocktail parties can be murder if you don't know some secrets for getting people to talk. Despite articles in the Reader's Digest and in many books telling us that the way to open any conversation is to merely get the other fellow to talk about himself, we seem to forget this basic rule. I've tried this on the air many times and it has seldom failed to open up an interesting QSO. I ask about the line of work and any other interests or hobbies . . . and the lid is off. Of course this means that you have to be good at listening. If you have a good set of your own interests the chances are that you will find a common subject that you can hash over with enjoyment. If not, then perhaps you can get your contact to tell you about somebody he knows that interests you.

Still, this is a hap-hazard system. Perhaps it can be developed a bit into something less chancy. Wouldn't it be nice if you could dial a frequency and find fellows there that share your interests? Ham pilots seem to enjoy swapping stories with other pilots when they chance to get together on the air. How about setting up a "net" frequency of pilots?

There are thousands of ham boaters, stinkpot and windy types. Some like houseboats, some water ski, some skin dive, some race.

(*Turn to pg.* 104)

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The Suppressor Compressor

The Neglected Grid

Allan S. Joffe W3KBM
531 E. Durham St.
Phila., Penna. 19119

We hams, just like most people, are prone to be creatures of habit. To illustrate my own personal groove, consider the pentode, a tube with three lovely grids plus other assorted parts. All my life I have fed a signal into the control grid, tied the screen to some B plus point and consigned the suppressor to ground or the top of the cathode bias resistor. There came the day when the painful process of thinking turned me out from my rut of indifference with interesting results. I knew from past tinkering that the screen was useful to control low frequency response in modulators and the like via the selective bypassing route. This in itself was perhaps the beginning of shrugging off old devil habit as the approach was a change from bypassing the screen and forgetting it. I decided to explore the personality of the suppressor and thereby hangs the tale.

The junk box supplied a small chassis with three octal sockets, to serve as a breadboard. The tube locker provided a 6SJ7 as the available pentode with the suppressor coming out to its own pin rather than being internally connected to some other element. As a jumping off point, I wired up the tube with average parts values for the tube used as an audio voltage amplifier as shown in **Fig. 1.**

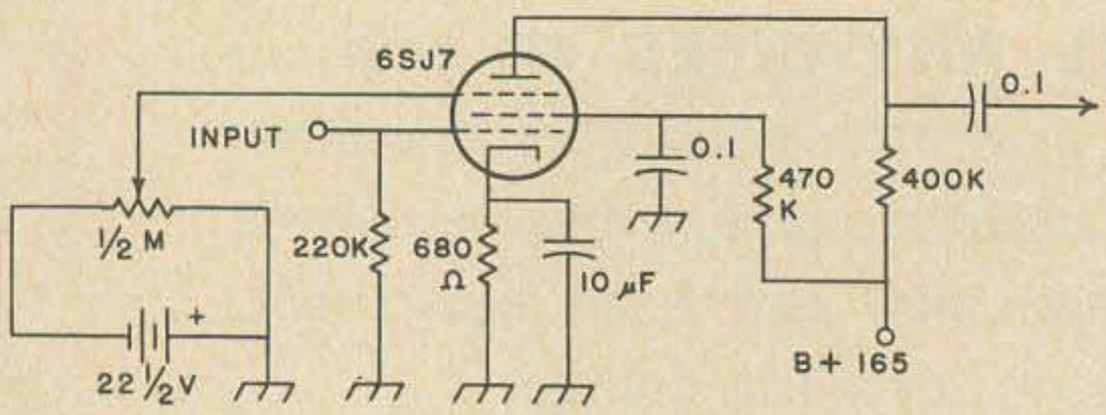


Fig. 1. Basic circuit of the Compressor, showing how a DC control voltage is applied to the suppressor *grid to control tube gain.*

Naturally the 22½ volt battery and the pot across it are not what you expect to find the well dressed voltage amplifier wearing but they were necessary to get some idea of what the suppressor characteristics would be. Increasing negative voltage on the suppressor brought to light one of those self evident truths "we all know". As the suppressor went more negative the plate voltage rose and the screen voltage fell. A little cogitating on the location of the suppressor, between the screen and the plate explains the foregoing. As the negative suppressor shuts off the electron stream to the plate, the screen becomes the dominant attractor, its current goes up and the voltage drop through the screen resistor goes up. Ergo! Since the project now showed promise of improving my education I forged on. The next addition was to be a triode amplifier following the pentode stage so that I could get enough voltage, signal wise, to use my db meter. With the addition of a 6J5 triode the circuit now looked like **Fig. 2.**

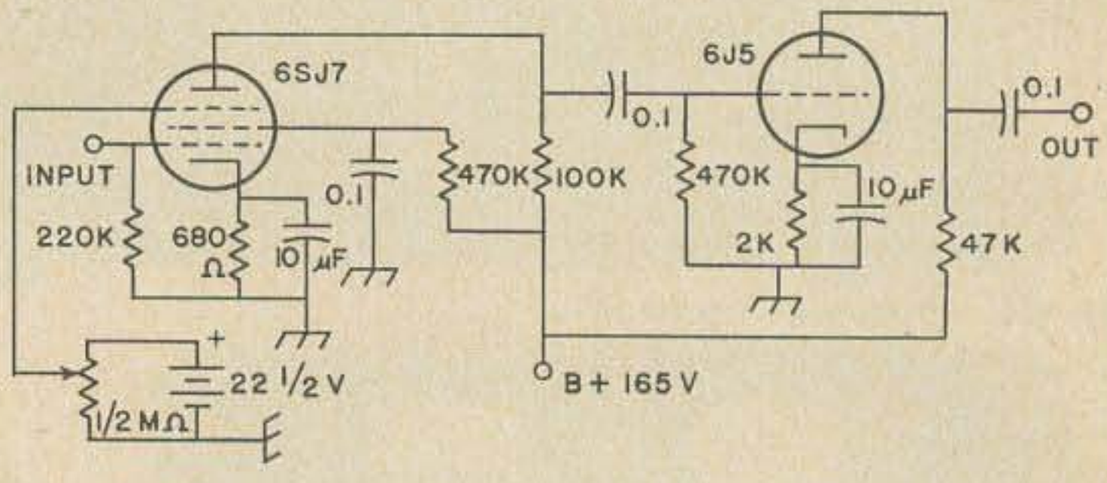


Fig. 2. This arrangement would be appropriate for remote control of audio gain. It has an effective control range of better than 20 *db.*

Feeding a 1 kHz signal into the input, the output was set at ten volts. If we can believe the attenuator of my audio generator it took about 8 millivolts input to produce the ten volts output which seems about reasonable from past experience. This overall gain figure was produced with the 6SJ7 suppressor at ground potential. The negative potential on the suppressor was now increased in two volt steps and the effect on the output was noted and recorded for posterity in **Fig. 3**

At this juncture in the proceedings it was about time to decide what I was building and where it was going. An electronic

Suppressor Bias	Audio Output dB
± 0	± 0 (10 V. at 6J5 Plate)
— 2	— ½
— 4	— ¾
— 6	— 1¼
— 8	— 2
—10	— 2½
—12	— 3¾
—14	— 4½
—16	— 6
—18	— 9
—20	—13
—22	—21

Fig. 3. Control characteristics of the circuit of Fig. 2. Remember to include a switch in the battery circuit to increase battery life.

primitive giving birth to a brain child can swing in many directions but the vine I grabbed led down the road marked "Audio Compressor". To quote from the Good Book, "You can derive a voltage from the audio signal and apply it to a suitable electrode in such a manner that the output signal will stay within proscribed limits when the input signal varies within reasonable limits". I felt that the suppressor grid would be a great "control electrode" and now all I had to do was derive a control voltage from the audio signal. If all the ideas I rejected to derive the control signal were detailed this article would rival *Gone Wih The Wind* in length. Naturally I realized the control signal needed would have to be dc in nature for simplicity and to avoid phase shift and feedback troubles associated with ac control signals. This led to the implication that I would need some sort of rectifier circuit but one with gain, if you please. The philosophy (a term meaning knowledge gained through hindsight) behind this decision was reached upon concluding the following.

A—the unit already had two tubes, and I am fond of even numbers.

B—I planned to pad the output of the little wonder down so it would feed proper level into existing mike gain stages, so high level signal voltages would not be available to me without tapping into the high level audio stages that followed the regular mike inputs. This was too cumbersome an approach so the control voltage had to be derived from the circuit as it now stood.

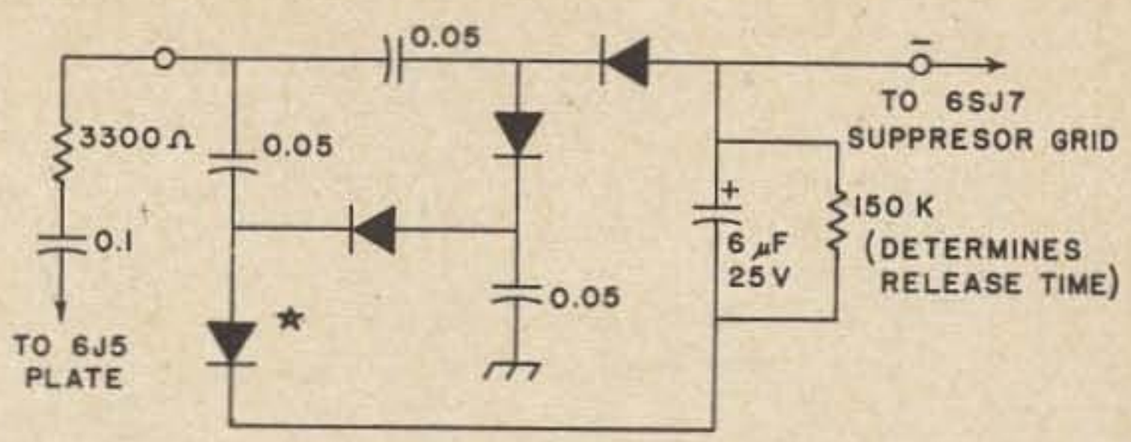


Fig. 4. An audio voltage-quadrupler circuit to develop the fedback control voltage in voltage compressor applications. It will offer a fast attack and slow decay.

C—Referring to the chart of Suppressor Bias versus Audio output (**Fig. 3**) indicated a need for up to 20 volts of control signal.

Since the 6J5 very easily provided in excess of ten clean volts of signal, I decided to use one of the standard voltage multiplying rectifier circuits, winding up finally with a voltage quadrupler as shown in **Fig. 4**. The choice of the quadrupler was made so that the voltage needed could be obtained at the same time that a reasonable amount of isolation could be put between the 6J5 plate circuit and the rectifier circuit to avoid lousing up the audio because of varying loading produced by the rectifier over the ac cycle and to avoid feeding any generated audio harmonics produced by the rectifiers presence to the following aduio stages. The 3300 ohm resistor and the 0.1 mF blocking condenser feeding the audio from the 6J5 plate to the voltage quadrupler was determined experimentally to be a fair compromise between isolation as discussed and attaining the needed control voltage.

Fig. 4 shows the interesting fact that three of the voltage multipler condensers are small (0.05 mF) but that the output condenser is, by comparison, a fair sized electrolytic (6 mF) These values were chosen so that the quadrupler would quadruple, but the output voltage rate of decay would be rather completely under the control of the 150 K resistor shunted across the 6 mF output condenser.

Regretably, no epic dealing with an aduio compressor can fully bypass a small discussion of attack time (the speed at which the unit takes hold and compresses) and release or decay time (the time interval required to restore steady state circuit conditions when a good sized peak has become history). I candidly admit that I don't know the attack time of this little gem but blandly state that whatever it is, I must be doing

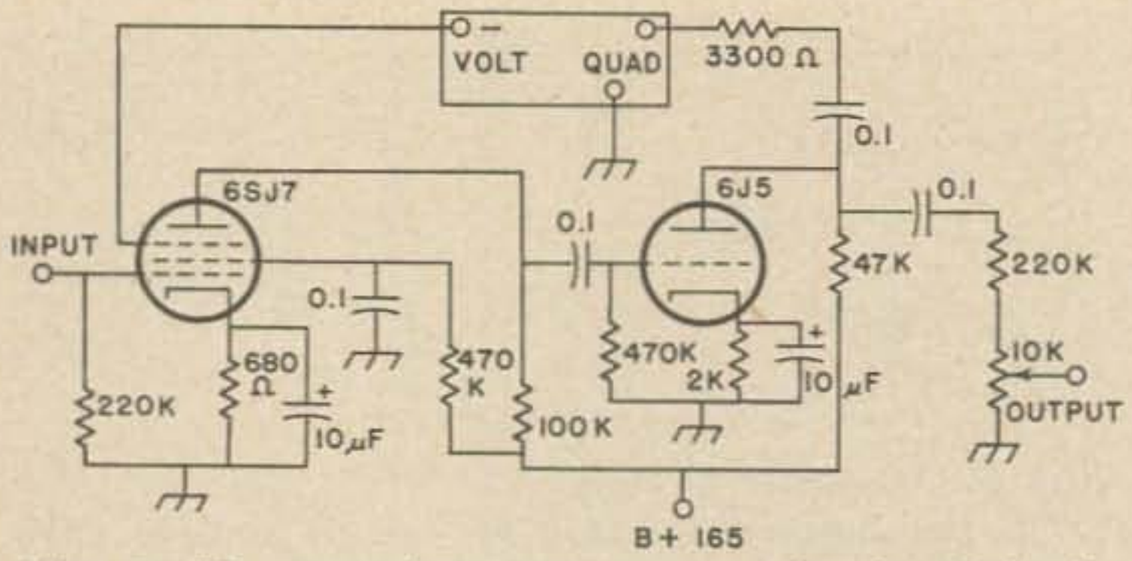


Fig. 5. The complete compressor circuit, with the quadrupler circuit replaced by the three-terminal box labeled "quad."

something right from the way it sounds in use.

The release time is easier to come by as you can readily time the decay of the control voltage by monitoring same with a VTVM and clocking the time of fall after hitting the input with a heavy "woof". The specified values give a release time of about 2½ seconds which works out well in practice for voice communication.

Fig. 5 gathers up all the pieces into the finished schematic of the practical functioning unit. For my own personal use (to feed my Gonset G-50) I used the output control circuit shown. There is no input gain control as the microphone used gives about 30 millivolts on close talking peaks. (a 100 millivolt signal will not overload the compressor or cause distortion). The audio to the G-50 is set by the output control on the compressor, which means that in normal use the compressor input is running wide open.

The Tabular data in **Fig. 6** is quite interesting. It shows the relationship between specific values of input signal, the resulting audio developed across the 6J5 plate load and the corresponding values of dc control voltage developed for application to the suppressor grid.

Notice that a change in input signal of 20 db (the range from 1 millivolt to 10 millivolts) gives an output change of about 13 db or a compression of about 7 db. If we push the input signal up to 30 millivolts (about 29.5 db over the reference 1 millivolt) then there is an effective compression of about 13 db. A 100 millivolt signal was applied experimentally with a recorded compression of some 21 db. The output as viewed on a scope was as clean as the signal produced by a 10 millivolt input signal.

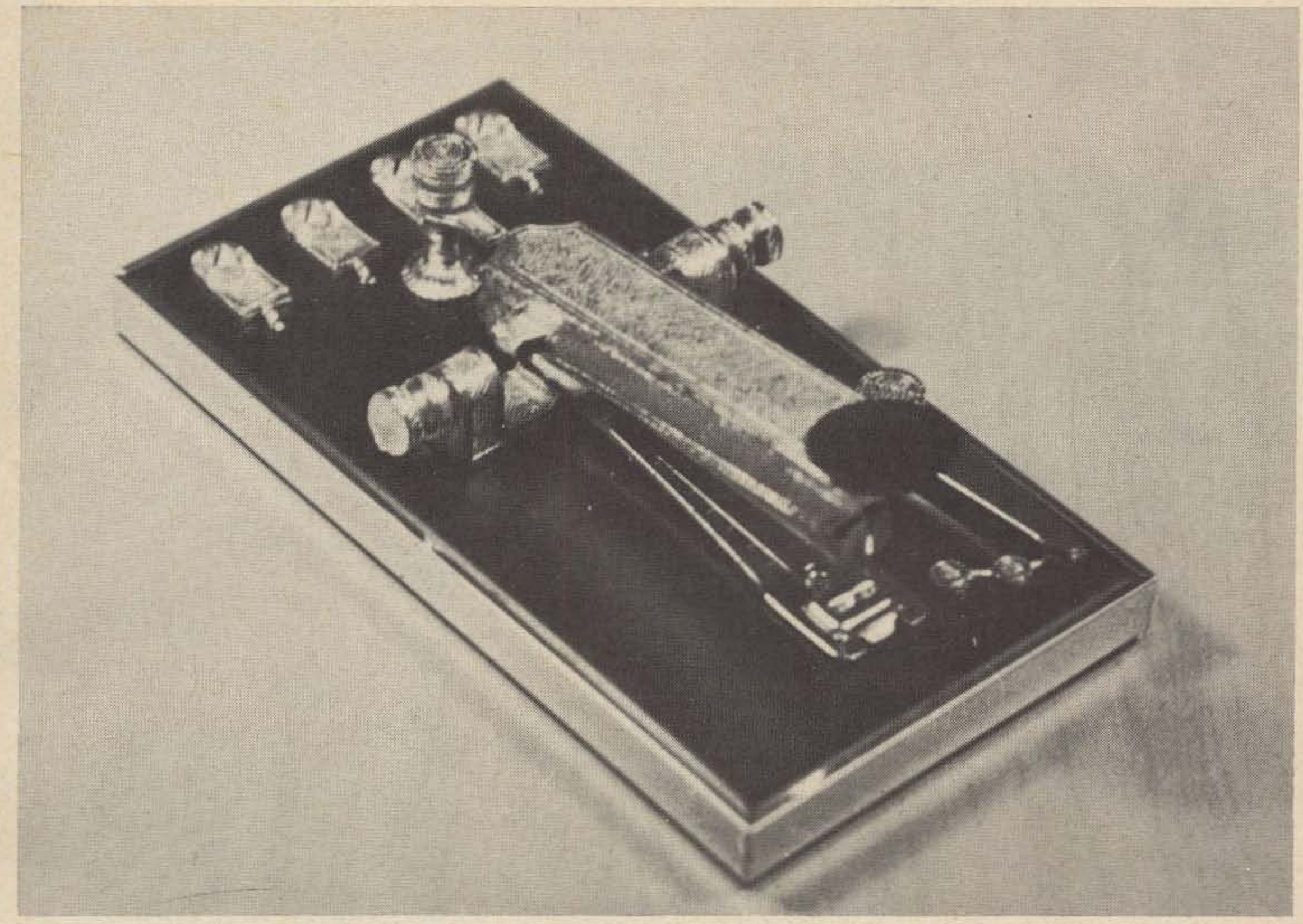
Some parting thoughts in retrospect. Like most hams, my shack is not loaded with expensive test gear. The measuring equipment used was a Heath Audio VTVM, a standard 20,000 ohms per volt multimeter and an RCA Jr. Voltohmyst plus an ordinary 5 inch service type scope. Halfway through the first set of measurements I had the inspiration to see if the three meters involved agreed one with the other. Needless to say they did not and the work was stopped cold until they were shaped up. (How do your meters stack up for agreement?) Since my mill is an old one constructed before superlatives were invented I have nowhere stated that the subject of this article was "the best" or the living end.

As a matter of fact, after this project came to a satisfactory conclusion subsequent mental modifications suggested themselves and just beg for somebody to try them out. The thought was that the 6J5 could be replaced with a dual triode. One half would be nothing but the audio channel and the other half just the amplifier for the control voltage section. This would eliminate the RC isolation network across the present audio plate load and a point of possible distortion. A pot could be placed in the grid of the control amplifier triode to give easy control of compression if this were desired.

. . .W3KBM

Millivolts Input	Volts Out	Control Volts
1	0.9	1.9
2	1.5	4.0
3	2.1	5.5
4	2.6	6.8
5	3.1	8.0
6	3.5	9.2
7	3.9	10.1
8	4.2	11.0
9	4.4	11.5
10	4.6	12.0
15	5.6	14.5
20	6.2	16.0
25	6.5	17.0
30	6.8	17.5
35	6.9	18.0
40	7.1	18.2
45	7.2	19.0

Fig. 6. For an input voltage variation of 45:1, *the output varies by* 8:1. *Use the control voltage readings to check the operation of your own circuit.*



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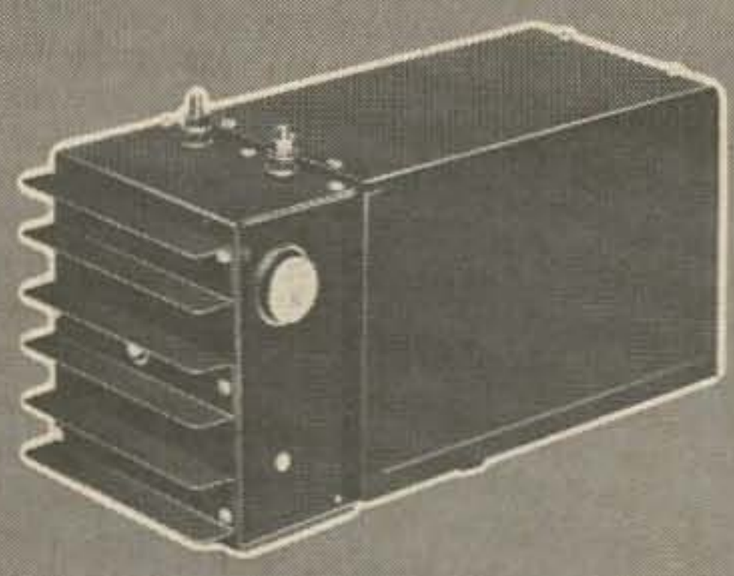

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Putting the HW-12 on 160 Meters

Dean W. Manley W8FGB
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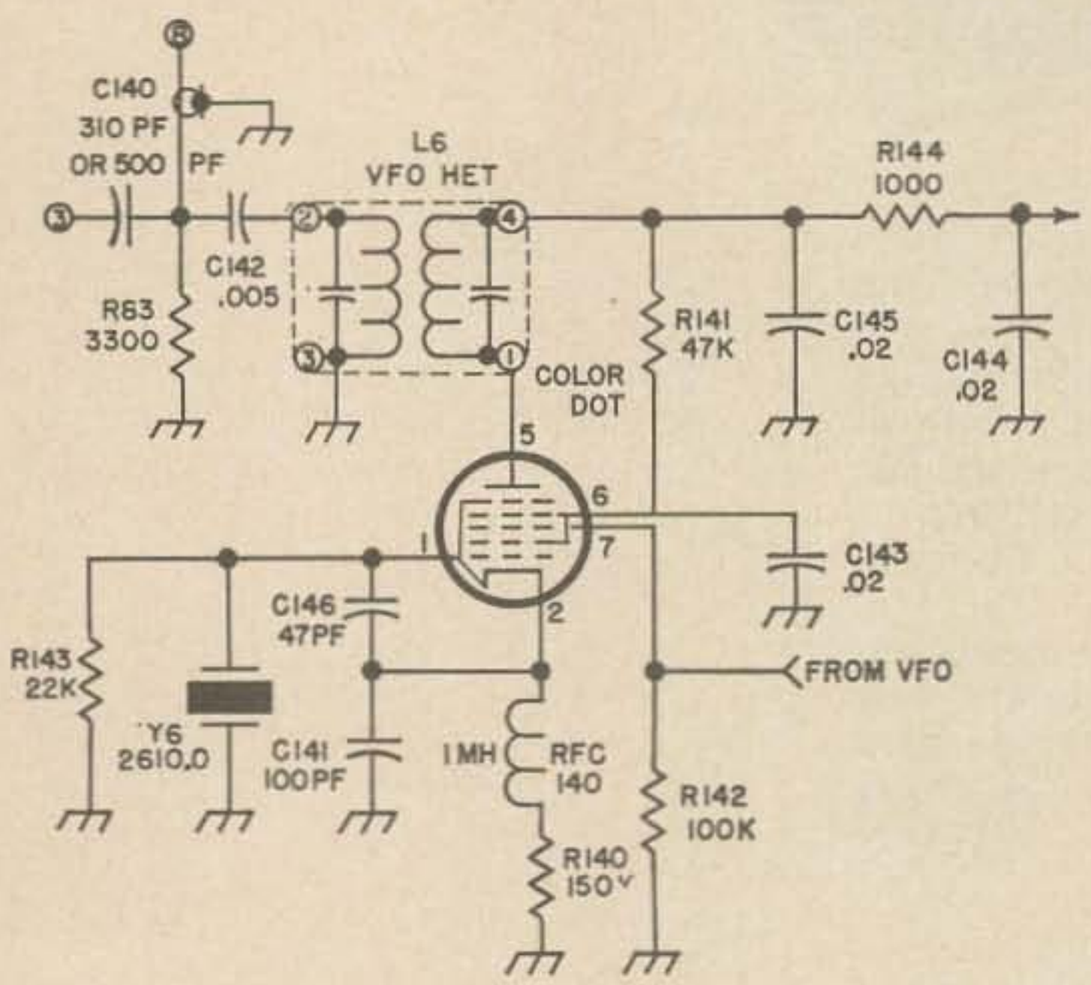

Carrier oscillator and heterodyne oscillator mixer

The SSB signal in the HW-12 is generated at 2.3 MHz and mixes with the 1.5-1.7 MHz VFO signal to get 3.8-4.0 MHz. After changing the VFO cathode follower, V14-6BE6 to a heterodyne oscillator mixer, the 1.5-1.7 MHz VFO mixes with the 2.6 MHz crystal oscillator. The output of the V14 Mixer is 4.1-4.3 MHz. When transmitting, the 2.3 MHz SSB signal is mixed with the 4.1-4.3 MHz in the V4-6AU6 xmtr mixer producing 1.8-2.0 MHz. When receiving, the incoming 1.8-2.0 MHz mixes with the 4.1-4.3 MHz from the V14 stage producing the *if* of 2.3 MHz. This conversion to 160 meters inverts the SSB signal. If we didn't change the crystal in the V11B-½12AT7 carrier oscillator stage, the converted HW-12 would respond only to upper sideband signals. This is easily remedied by changing the V11B stage crystal from 2306.7 kHz to 2303.3 kHz and the modified unit will respond to lower sideband (LSB) signals, both transmitting and receiving.

Transmitter driver and receiver rf

Modification of this part of the HW-12 only involves changing the L2-DRIVER GRID and L3-DRIVER PLATE coils. These coils also serve as *rf* stage coils in the receive mode. The coils are removed and modified, and then re-installed.

Transmitter pi-net

This portion of the modification affects only the transmitter section. The Pi-network tank variable C65, capacitors C66 and C67 (68 pf each), tank coil L4, and loading capacitor C77 are removed and their 160 meter equivalents are installed.

Whether you obtained your HW-12 new or used, the 160 meter modification should not be undertaken without reference to the Assembly Manual supplied with the kit. Not only is the manual helpful during the process of the modification, but it should be used to check the performance and alignment of the HW-12.

It is strongly suggested that time be taken before modification to measure and make a written record of voltages. Reference is particularly made to Figure 12 on page 52 and Figure 13 on page 53 of the HW-12 manual. Before the actual modification is started, make sure that the HW-12 performs normally on 3.8-4.0 MHz. This could very well save time and headaches later.

Parts needed for 160 meter modification

Besides the HW-12 and it's power supply, the following lists of parts is required for the 160 meter modification: (One of each required, unless otherwise specified)

2303.3 kHz crystal, Heath 404-196
80 Meter Driver Grid Coil, Heath 40-516
33 pF mica or ceramic capacitor
47 pF disc capacitor
56 pF, 4kv disc capacitor
100 pF disc capacitor

220 pF, 4kv disc capacitor
2000 pF (.002 mF), 500 volt mica capacitor
.02 mF disc capacitor
150-ohm, ½ watt, 10% resistor
1000-ohm, ½ watt, 10% resistor
22K, ½ watt, 10% resistor
1 mH *rf* choke
B&W Miniductor 3019 (see text)
Hammarlund MC-140-S transmitting variable
2610.0 kHz crystal, JAN Crystals (HC6/U holder)

Also, a small quantity of small size wire suitable for rewinding coils L2 and L3 is required. Sizes between #30 and #36 is suggested. The winding from an old 2.5 mH *rf* choke or a broadcast oscillator coil may be used. If it is decided that total coverage of the 160 meter band will not be used for transmitting, then the new 140 pF variable capacitor will not be required. The present final tank capacitor C65, 50-50 pF will cover at least one 25 kHz segment of the band. In this case, experimentation may be required for the exact values of the capacitors in parallel with the final tank variable to cover the desired 25 kHz segment of the 160 meter band.

It should be noted here that the new 80 meter Driver Grid Coil will be used for the Heterodyne Oscillator Mixer Coil L6 for 160 meter operation.

Modification

Carrier oscillator and heterodyne mixer

Remove the present carrier oscillator crystal Y1-2306.7 kHz and install the new crystal 2303.3 kHz. Remove the following parts from the V14-6BE6 VFO cathode follower: R140-1000, C141-310 pF, RFC-140-15 μH, and the jumper wire connecting V14-Pin 1 and Pin 7. Remove R141-47k and temporarily set aside for later installation.

Locate the new 80 meter driver grid coil (Heath 40-516) to be modified for use as L6 heterodyne oscillator mixer. Remove the coil from the shield can and then remove the 390 pF capacitor. Remove one end of the 100 pF capacitor and coil lead from pin 2. Remove the coil lead from pin 4 and solder it to pin 2. Now solder the free end of the 100 pF capacitor and the remaining coil lead to pin 4. Install a 33 pF capacitor between pin 2 and pin 3. Re-install the coil in the can and the install the completed L6 on the printed board between V13 and V14. Pin 1 of L6 goes to V14-pin 5.

See **Fig. 1** for the installation of the parts in the het osc mixer. Double check to be sure of the proper location of each part before installing the part. Then install the part and check again for possible errors! It is easy to make errors, especially if you're not familiar with printed boards.

Locate C142-.005 on the printed board and remove the lead going to V14-pin 2. Connect this free end to L6- pin 2. Now locate C140-310 pF and remove the lead nearest V14. Connect the free end of coaxial cable, and R83-3300. Install the following parts: R140-150, R141-47K, R144-this capacitor to the junction of C142.005, 1000, R143-22k, C141-100 pF, C146-47 pF, C145.02, RFC140-1mH, and Y6-2610.0 kHz.

Driver coils L2 and L3

Remove L2 from the printed board and remove the shield can. Carefully add approximately 35 turns "Scramble-wound" to each winding. Wind over the present winding and away from the adjacent winding. Do not wind in the space between the primary and secondary windings. Check the windings with an ohmmeter and then re-install in the shield can noting the position of the color dot. Re-install L2 on the printed board.

Remove L3 from the printed board and remove the coil from it's can. Remove the windings, noting the pin connections. Wind a 6-turn link to pin 2 and pin 3 in the same location on the form as the original winding. Now wind approximately 85 turns over the link using the "scramble-winding" method and connect to pin 1 and pin 4. Check with an ohmmeter and then re-install in the shield can noting the color dot. Install L3 on the printed board.

Transmitter pi-net

Remove the following parts from the HW-12: 80 meter tank coil L4; final tank capacitors C65-Variable, C66-68 pF, C67-68 pF; and the loading capacitor C77-1000 pF.

Install the new C77-2000 pF capacitor in place of the old C77. Install the entire B&W 3019 Miniductor or wind 36½ turns of No. 16 enamel closewound on a 1¼-inch

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diameter form 3-inches long. The winding will take up about 2-inches. Install the variable capacitor at the final tune location on the front panel. Install the fixed capacitors from the hot side of the variable capacitor to ground. The fixed capacitors are 220 pF and 56 pF at 4kv. Solder a lead from the top of coil L4 to the hot side of the tank capacitor combination C65-C66-C67.

Alignment

Follow the procedure outlined in the HW-12 manual for the alignment of the VFO dial calibration, bias setting, *if* amplifier adjustment, and balanced modulator adjustment.

Het OSC mixer alignment

1. With the VFO dial set to 1.8 (3.8), turn the function switch to the tune position and the meter switch to tune operate.

2. Adjust the upper slug of coil L6 for maximum output.

3. Set the VFO dial for 2.0 (4.) and adjust the bottom slug of L6 for maximum output.

4. Repeat steps 1, 2, and 3. If results are not satisfactory, try adjusting the upper slug at 2.0 and the bottom slug at 1.8

Driver alignment

1. Adjust the upper slug of driver grid coil L2 for maximum output at 1.8.

2. Adjust the bottom slug of L2 for maximum output at 2.0.

3. Adjust the slug of Driver plate coil L3 for maximum output at 1.9.

4. Repeat the steps as necessary for the desired results. If flat response across the entire band is not obtainable, then try for response across the desired 100 kHz portion of the band. For example: adjust one slug of L2 at 1.8, the other slug of L2 at 1.9. Adjust L3 at 1.85.

Now go back to L6 and adjust if necessary for response across the desired portion of the band.

Gratifying reports were received on 160 meters saying that the rig sound every bit as good as an unmodified unit on 75 meters.

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Tuning a Parasitic Beam

Kayla Bloom W1EMV
P.O. Box 224
Dublin, N.H. 03444

Most antenna construction articles don't go into much detail on making tuning adjustments. If you are not familiar with the tuning details, it can take twice as long to tune the beam as it took to build it.

In spite of all the elaborate antenna designs which have been developed in recent years, the old grounded "Plumber's Delight" parasitic beam remains one of the most popular antennas for HF and VHF bands. Reasonable gain can be achieved with two or three element beams using .1 to .15 spacing of elements. Construction is easy and materials for building such a beam are readily available almost anywhere. It can be made rugged to withstand weather conditions and normally won't require any servicing once it is properly tuned and installed. Finally, with few exceptions, it provides much more satisfactory performance than antennas made of wire elements.

Among other advantages, we should also add that it is really easy to tune, both for forward gain and front to back, if you know the procedure.

We won't deal with construction details here, since those are available in handbooks, antenna handbooks, and in numerous articles which have appeared in ham magazines over the past years. Typically, these articles devote much time to construction of the beam itself, including the usual Gamma matching section, but only passing mention is made of the details of tuning adjusting for maximum performance.

To the experienced antenna builder, this article will be of little value. However, for the Novice or new ham, tuning a beam can be a frustrating experience which requires an inordinate amount of time, sweat, and even tears. Many a beam building project has been abandoned at this point, or has simply been put into service with less than optimum performance. I repeat . . . . tuning a beam is easy.

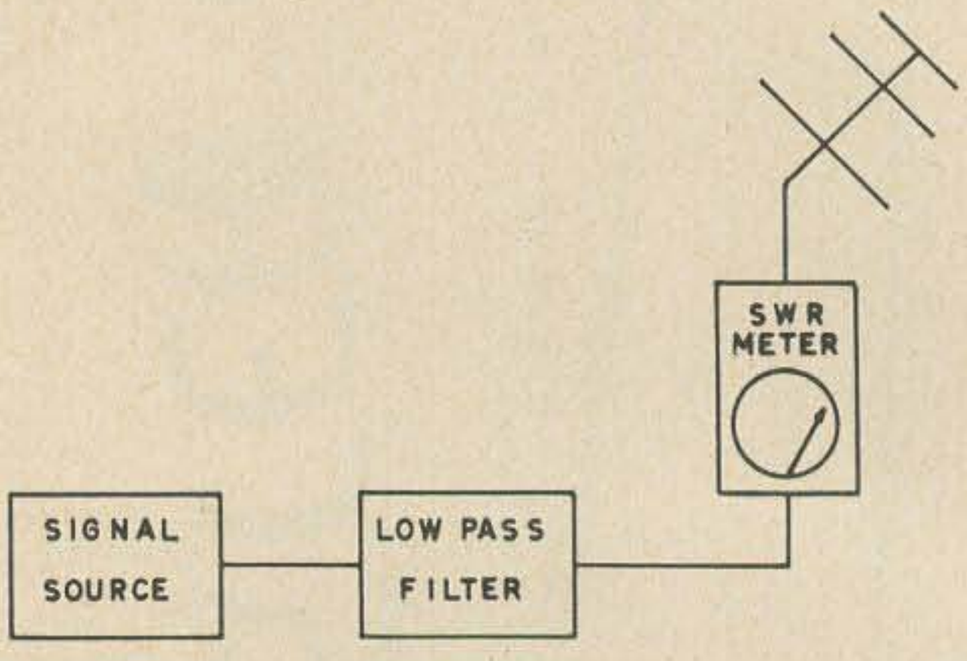


Fig. 1. Equipment diagram for driven element matching adjustments.

This article will deal with the single band, Gamma matched beam, and will show you how the beam can be tuned easily and quickly, to give you the best performance. After all, you are going to devote a good deal of time to constructing the beam, now, let's get the most out of it. Don't rush! There are certain pieces of equipment you will need to do a first class job. If you don't own them, borrow them. It is also helpful to have one other person to assist, but it can be done alone.

First, let me make one point clear. It is virtually impossible to achieve maximum forward gain and maximum front to back ratio on the same beam. The forward gain is determined primarily by the element spacing and the efficiency of the driven element. The front to back is determined by the length of directors and reflectors, although both are important in the case of forward gain. In nearly all cases a compromise must be reached if one factor is not to be sacrificed. However, the following procedures will usually give the best results without losing too much on either forward gain or front to back.

Test setup for matching adjustments

Once the beam has been constructed ac-

cording to the dimensions outlined in an article or antenna manual, the next step is to adjust the matching section on the driven element of the beam for correct matching to the transmission line. It is desirable to make these adjustments with the beam in its final location, but since this is usually a physical impossibility, the idea is to get it as far above ground as is possible. Keep it as far away from obstructions, especially large metal surfaces, as you can. For HF beams, a tall stepladder will suffice.

Correct matching conditions are indicated by obtaining the lowest SWR reading possible on the coax transmission line. As shown in **Fig. 1.**, the SWR meter should be located as close as possible to the antenna end, not the transmitter end of the transmission line. There are two reasons for this. First of all, if the transmission line has any appreciable losses, a false reading will occur at the transmitter site and usually will appear better than the actual situation at the feed point of the antenna. Secondly, you will want to be in a position to observe the readings on the SWR meter as you are making the adjustments in the matching device. Therefore, you will need a SWR indicator of one type or another. This can vary from a simple home-brew "Monimatch" which will cost pennies to construct, to an elaborate commercial Wattmeter which will cost more than pennies. Since we are concerned with the power getting to the antenna and the amount being reflected back to the transmitter, any reliable SWR indicator is acceptable.

An absolute minimum of connectors should be used in the coax line, including those used at the SWR meter. While new connectors usually don't introduce significant loss, each one is a potential source of future problems due to corrosion, etc. There rarely is a need for a connector at the antenna feed point, and a soldered (not twisted) pigtail connection is best. Soldered pigtail connections should definitely be used during adjustments.

The transmitter, or other signal source, must first be properly matched to the transmission line. A dummy load at the antenna end, with the SWR bridge at the transmitter end will confirm this match. Once the transmitter is tuned up with the dummy load, these adjustments should not be changed throughout the entire tuning procedure. **Fig. 1.** shows a low pass filter at the transmitter end because harmonics fed to the antenna will cause false readings. Most present day transmitters have harmonic content low enough to prevent any problems, but some harmonics are always present and unless you use an expensive signal generator as the power source, the use of a low pass filter is a necessity. Most of the less expensive signal generators have, at best, a broadly tuned output circuit and the harmonic content can be high.

Now what about the accuracy of the SWR bridge? If you were able to achieve close to a 1:1 ratio with the Dummy load at the antenna and the SWR indicator at the transmitter, it is reasonable to assume it is correctly calibrated.

Adjusting the matching section

Most beam of this type use the Gamma matching section shown in **Fig. 2A**, although the Delta match shown in **Fig. 2B** does have some advantages, and is still used in some construction. There are several ways to explain the action of the Gamma match. One concept is that the loop 1-2-3-4 induces a voltage in antenna section 1-2 which is then coupled to the rest of the driven element. Since the loop 1-2-3-4 is not large enough to be resonant, its inductive reactance must be cancelled out by the series capacitor in leg 3-4. As long as legs 1-2 and 3-4 are reasonably closely spaced, they act similar to a transmission line, and no radiation occurs from the matching section.

Generally the dimensions chosen for the

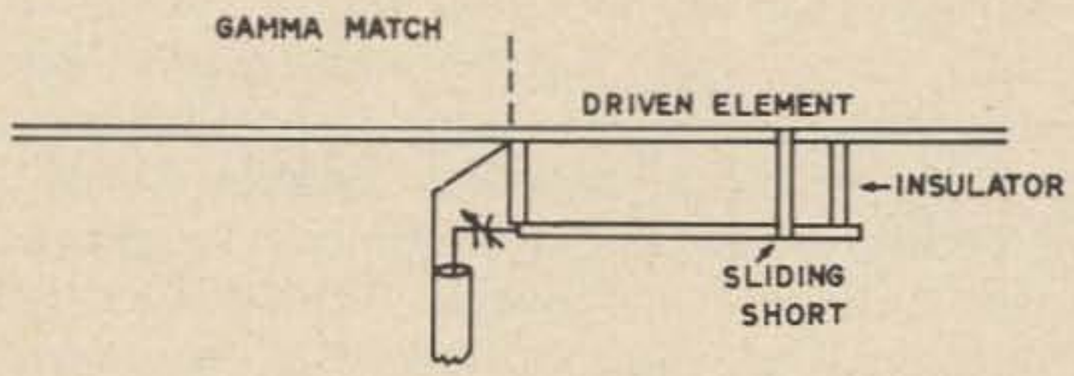


Fig. 2. (A) Basic form of Gamma match and (B) Delta match.

Gamma section are such that its length is from 1/10 to 1/16 of a wavelength and the spacing between sections is 1/30 to 1/60 of a wavelength with the maximum value of the series capacitor in pF being 7 times the wavelength in meters.

The adjustment now depends upon whether you have built the beam from the dimensions given in a construction article in a magazine or manual, or whether it is an individual creation. In the first case, assuming a series capacitor has been used in the Gamma match, the procedure is as follows.

1. Using a transmitter or rf signal generator, excite the antenna with sufficient power to obtain a reasonable indication on the SWR meter.
2. Adjust the sliding short for minimum SWR, or at least a decrease in SWR reading.
3. Adjust the series capacitor for minimum SWR reading.
4. Go back and forth between steps 2 and 3 to get minimum SWR indication. The SWR *must* go through a rise-dip-rise-dip sequence.
5. After the minimum possible SWR indication has been obtained, adjust the driven element length (try lengthening first for a further reduction in SWR indication. This is fairly critical and on a HF beam should not be more than a few inches in length. Remember, at this point the reflector and director(s) should not be adjusted.
6. Finally, double check the final SWR reading by going through the calibrate procedures for the type of SWR meter used.

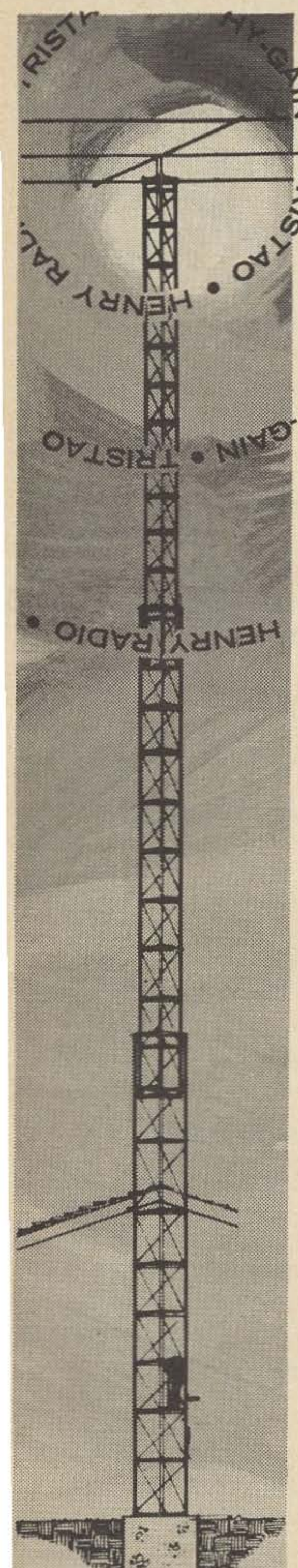
In the case of an individually designed beam, where we assume dimensions are pretty close to "text book" specifications, (both spacing and element lengths) it is a good idea to check the frequency resonance of the driven element first. Where there is a difference in element diameter, the resonant frequency of the driven element may be far from the expected value. The Gamma match section may be connected in some temporary way and the signal source frequency varied to check to see that a broad SWR dip occurs near the desired frequency. Here we find a grid-dip meter to be an invaluable aid. With the feedline disconnected and a few inches of wire attached to the feed point of the driven element and loosely coiled around the grid-dip meter coil, a pronounced dip will occur at the resonant frequency of the driven element. Be careful here, because other minor dips may occur. There is no point in continuing with the matching section adjustments until the resonant frequency of the driven element is established. Once this has been determined, the same steps should be followed as outlined for the other version.

If you want to eliminate the difficulties usually encountered by the use of a series capacitor in the Gamma leg, this too can be accomplished simply. Instead of using step 3 in the sequence, vary either the spacing between the Gamma section and the driven element, or vary the diameter of the Gamma section. This requires the patience of a Saint, and the SWR may never reach the desired 1:1. However, if you get close (1.2 or 1.3:1) it is worthwhile to accept the adjustment and gain the advantage of not having another component, way up there on the tower or mast, which could ultimately break down and cause problems.

The Delta match is appealing because of its simplicity, but it can prove more difficult to adjust. It is possible to simply use the center conductor of the transmission line on the Delta match leg. The dimensions shown in **Fig. 2B** should be considered to be approximate and merely as a crude starting point. Once the driven element has been adjusted for resonant frequency, the adjustment of the Delta match follows much the same procedure as that for the Gamma match. Instead of adjusting matching section length and spacing, however, dimension A and B of **Fig. 2B** are adjusted for minimum SWR. The procedure is time consuming and tedious, however, and spare coaxial cable should be allowed in the event that, on the first try, too much of the center conductor is cut away. On the other hand, the end result is an extremely simple, highly reliable feed system.

Adjusting the parasitic elements

These adjustments don't necessarily have to be made. Most beams, when cut to "text book" dimensions, will perform well. However, there is always the goal of producing the last db of possible performance from a beam. If properly constructed in the same manner, and of the same materials, there is every likelihood that the proper frequency relationship will be retained. The reflector should be 5% longer than the driven ele-



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ment, and the director should be 4% shorter. Each additional director should be made successively 4% shorter until the third director element when the length remains constant for any additional elements.

Here we get into the compromise situation between forward gain and front to back ratio. This, of course, depends on the individual's wishes in the matter. In some areas of the country the front to back is less important than in others. Forward gain is the prime factor. In others, the curtain of signals coming in from the back of the beam, may make the difference in hearing a DX station and not hearing him. Having lived in Hawaii, Colorado, and now the East Coast, there are three sets of circumstances and my beam tuning has changed with the circumstances.

In Hawaii, there was little QRM from the West, but an iron curtain of Western U.S. stations to the East. There, forward gain was important. In Colorado, where QRM came from both East and West, front to back ratio was important if I wanted to hear the incoming signals. Here in the East, I find a compromise situation must be achieved. The individual will have to make his own decision as to this approach to efficiency. In many cases, the loss of a db or two in forward gain is worth the added attentuation of signals coming in off the back of the beam.

Tuning for maximum forward gain

A field strength meter is placed at least two full wavelengths directly in front of the director's path. A short horizontal dipole connected to the field strength meter is best, but a vertical antenna will work reasonably well in these measurements. The beam is excited and a reading taken. Here is where the second person can be utilized to take the readings. However, I have found good results using a pair of good binoculars or even a telescope to make the readings alone. A telescope allows readings from a greater distance, but at two wavelengths, binoculars will do well. The meter should be isolated from reflecting surfaces and should not be held by another person. After an initial setting is obtained, the meter adjustments should not be changed. The beam's reflector and/or directors should slowly be changed in length for maximum indication on the meter. These adjustments will be

broad, but should show a definite rise and fall in the meter reading with changes in length. Continue this process until maximum field strength readings are obtained.

Tuning for maximum front to back ratio

To achieve maximum front to back ratio, follow the same procedures described for forward gain, but have the reflector element facing the field strength meter. The reflector element should be adjusted for a minimum dip on the field strength meter. This dip should be quite sharp as small changes are made on the reflector length. The director should be then adjusted for a null on the field strength indicator. This adjustment will be much broader than that of the reflector.

A compromise between forward gain and front to back ratio can only be made with a three element (or larger) beam, and requires a combination of the previous procedures. Basically, the directors are first adjusted for maximum forward gain (first adjusting the director nearest the driven element) then the beam is turned 180° and the reflector is adjusted for minimum field strength reading. The director(s) is not readjusted.

In all these adjustments, low power should be used not only to reduce the physical problem of *rf* "tingles" and/or possible burns, but to reduce the QRM radiated on the given band. Use only the amount of power required to produce adequate readings. If working alone, it would be wise to locate the transmitter or signal source where it can be kept under control at all times.

After all these adjustments have been made, it is a good idea to check the driven element SWR again, especially if the transmission line has been removed from the beam at any time. Unless the parasitic elements have been changed drastically, there should be no significant change in SWR. It may have improved somewhat in the process. However, a final check is in order before removing the test equipment and permanently installing the beam at the top of the tower.

One final word. I have found it to be more successful in the tuning of the driven element to remove it from the beam and isolate it for the initial tuning. Make believe you have a dipole antenna and tune it as if it were the only antenna you were going to use. Then reassemble it on the boom and make the other tests. This is minor, I assure you, but if you are looking for that last db of efficiency, it can mean a JND (just noticeable difference).

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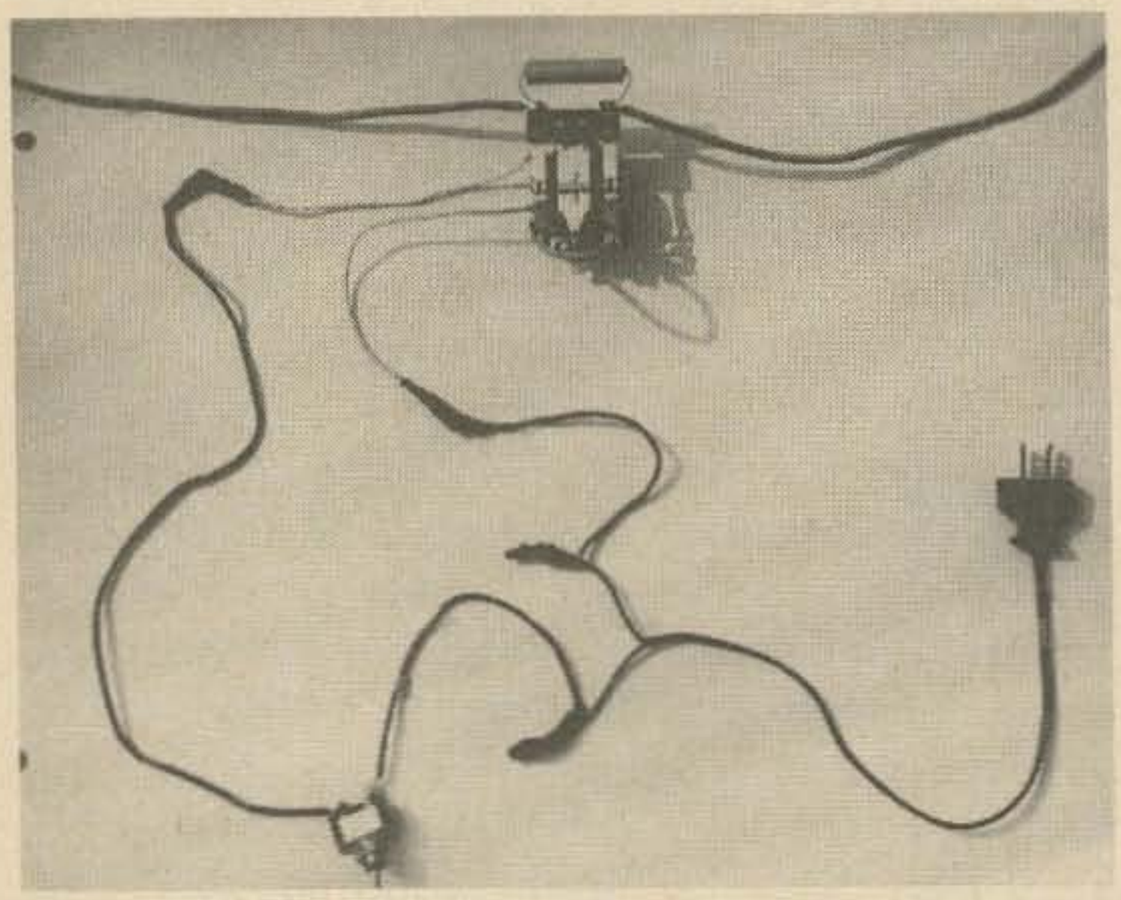

Mockup of the modification. Plate supply ground return contains a 5000 ohm resistor, shunted by the normally closed relay contacts.

Has your linear started blowing fuses when you turn the plate switch on to tune up? Or maybe the mercury-vapor tubes inside are frequently flashing a bright bluish-purple? Could be you have heard a disturbing "thump" from the power transformer as well!

You may know about a cold pill to cure wheezing, sneezing, and assorted miseries, but would you believe one simple modification to your rig can end fuse blowing, tube flashing, and transformer thumping all at once?

These troubles may start as you turn on the plate switch of the linear if the sine wave of the alternating supply is almost to a peak. This causes the rectifiers to send an enormous inrush of direct current to the starved filter capacitors. Even if a fuse doesn't blow, this surge won't do the mercury vapor tubes a bit of good. And the jarring thump of the transformer may shake you up so much that you miss that choice DX station who just called CQ on the frequency where you're listening.

The filter in my factory-built linear consisted of six 100 μF capacitors in series with equalizing resistors across each one. I merely opened the low potential lead from the grounded center-tap of the plate transformer and inserted a 5000 ohm, 20 watt resistor in series. Then I connected a relay with normally-closed contacts in parallel with the resistor with a jumper to short circuit it. The primary coil of the relay is operated by a toggle switch mounted on the front panel. The 120 volts ac for this is picked up where the line enters the cabinet and is protected by the unit fuse, of course. The 5000 ohm resistor is permanently wired in the circuit. Whether the relay is energized or not, there is no time when the center-tap of the plate power transformer is open. Be sure your relay is wired in this manner.

When the fialment switch is closed, the mercury vapors heat; then, the modification switch is closed, and the relay removes the short circuit from the 5000 ohm resistor. When plate power is turned on, this extra resistance allows the filter capacitors to charge more slowly. You will notice a momentary brightening of the mercury vapor tubes but no flash, no thump, and no blown fuse.

After opening the modification switch, you're all set to call and work that DX station, so get after it!

. . .W9VEY

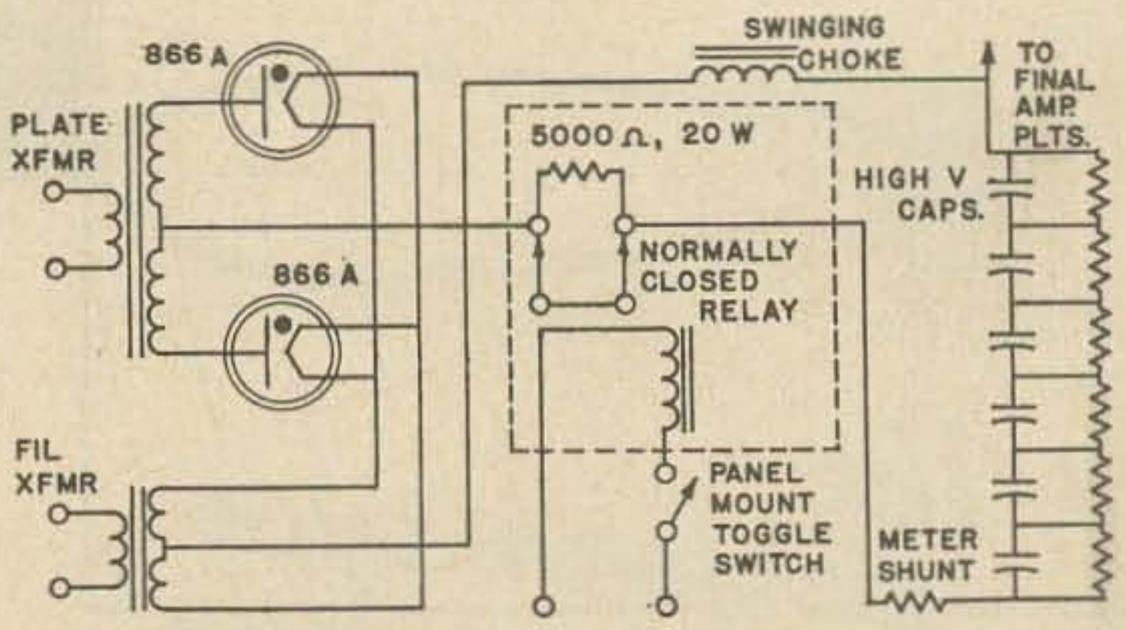

Fig. 1. Modification shown within dashed lines prevents quick inrush of charging current to capacitors. This reduces strain on fuses and mercury vapor rectifiers. Also good for semi-conductor rectifiers.

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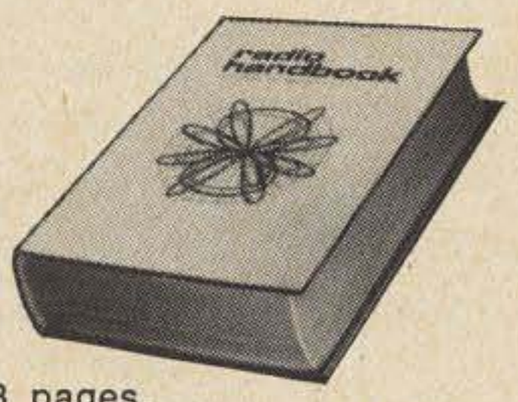

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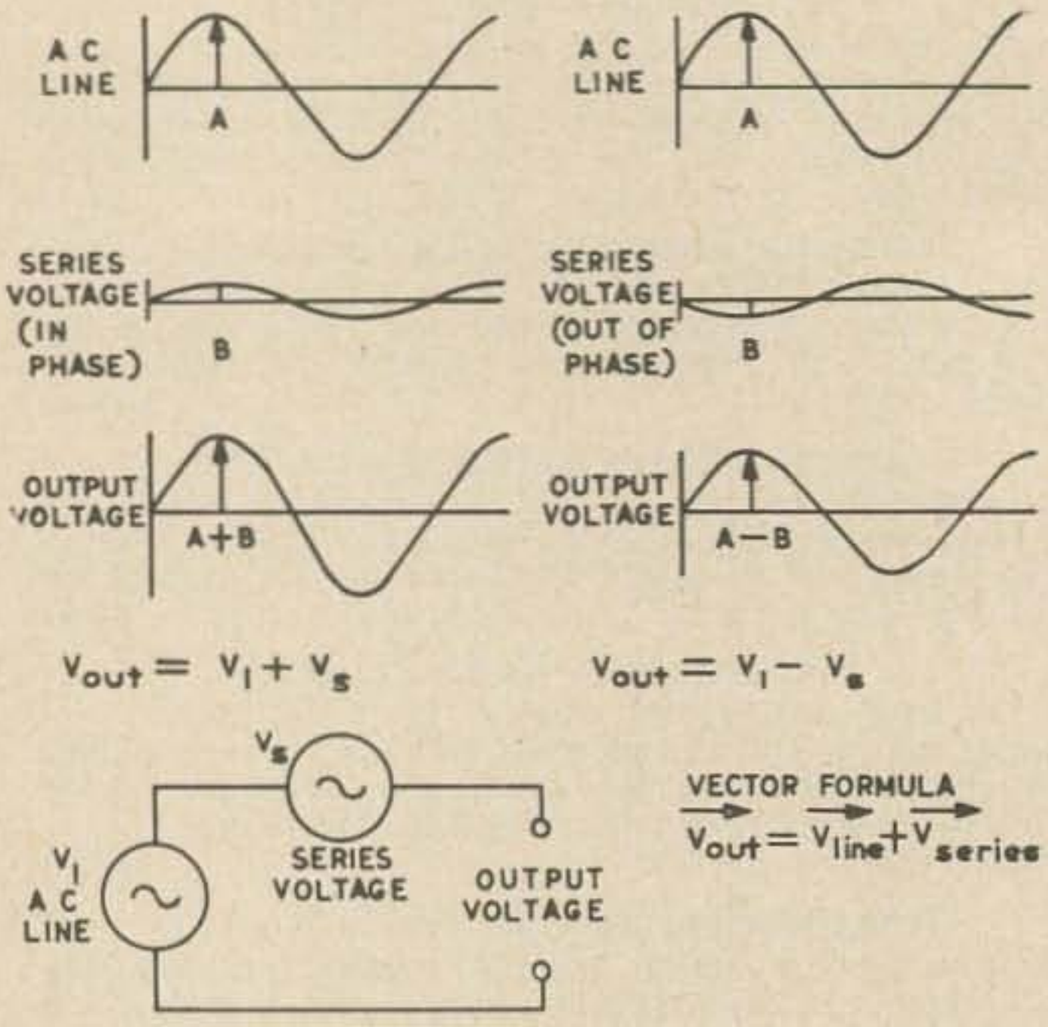

Fig. 1 Boost/Buck system of voltage control. V1 and Vs must be of same frequency sine-wave output to preserve.

An earlier article[1] by Jim Kyle, concerning adjustment of an ac line voltage by the "Boost/Buck" system, prompted some further thought and experimentation along a similar line. Although the underlying theory of the system described by Kyle simply involves vectorial addition of two ac voltages of the same frequency, there is some tendency to confuse it with the system of **Fig. 2.** The boost-buck system explained in **Fig. 1** is often used in small line voltage regulators for field day use, the series voltage being derived from a step-down transformer whose primary is paralleled with the ac line voltage. **Fig. 3** shows such a system. Since the phase shift across the transformer is 180 degrees (or nearly so) the series voltage can be made to boost or to buck the input voltage with a reversal of either the primary or secondary transformer leads. For the in-phase case the vectorial addition of **Fig. 1** becomes simple addition; and for the out-of-phase case the resultant voltage is the difference of the other two.

The system illustrated in **Fig. 2** involves changes in the magnetic flux densities of the transformer core. This method may be used to vary the output voltage of a dc supply of the transformer type. Basically then, if a secondary winding is connected with the transformer primary in "series-aiding" the flux density due to the primary current tends to be greater. This translates into increased voltage induced in any other windings. Conversely, the flux density would decrease should the two windings be connected in a "series-opposing" fashion. **Fig. 5** diagrams a dc power supply which employs this technique.

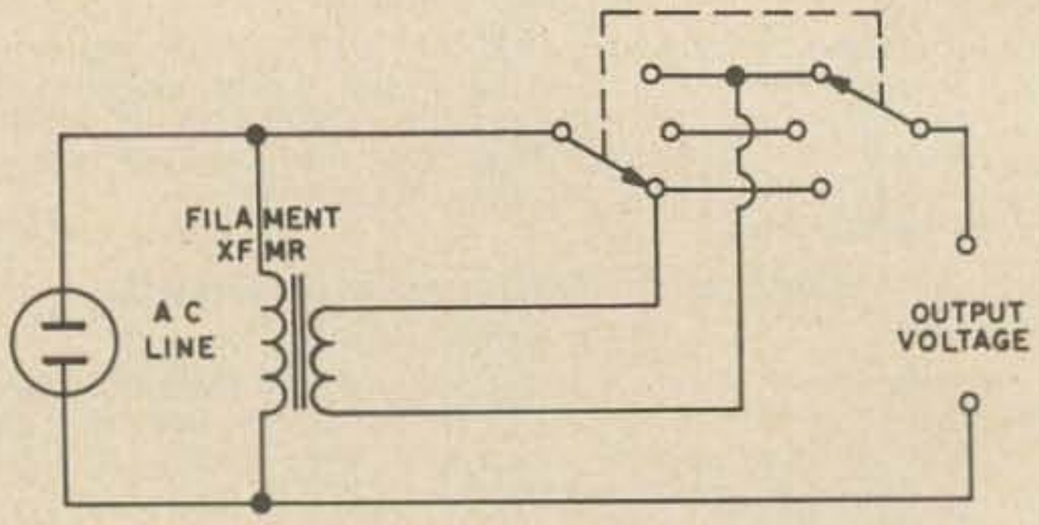

Fig. 3. Practical "Boost/Buck" manual voltage controller.

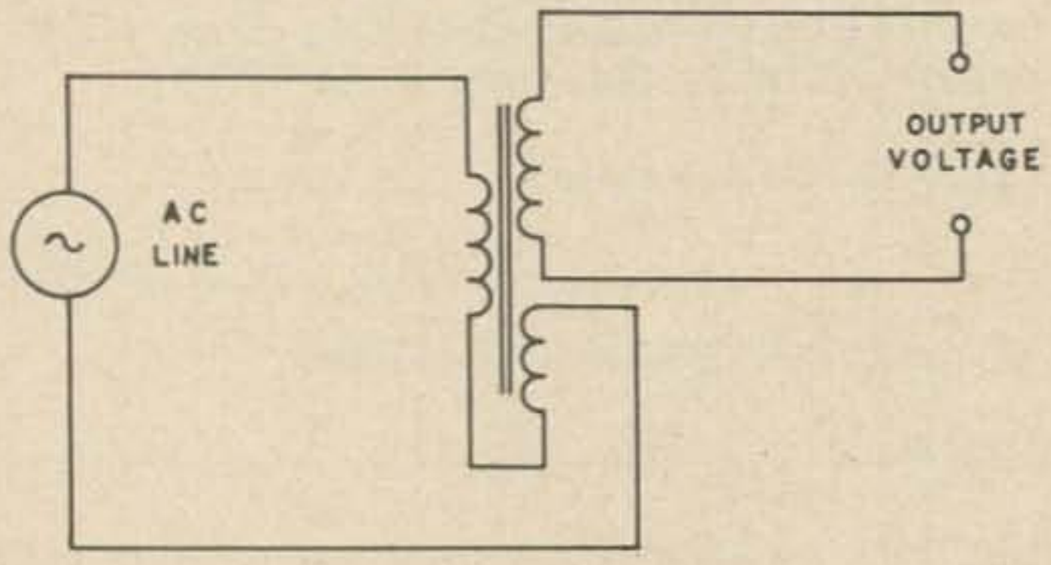

Fig. 2. The "Series-Aiding/Series-Opposing" system.

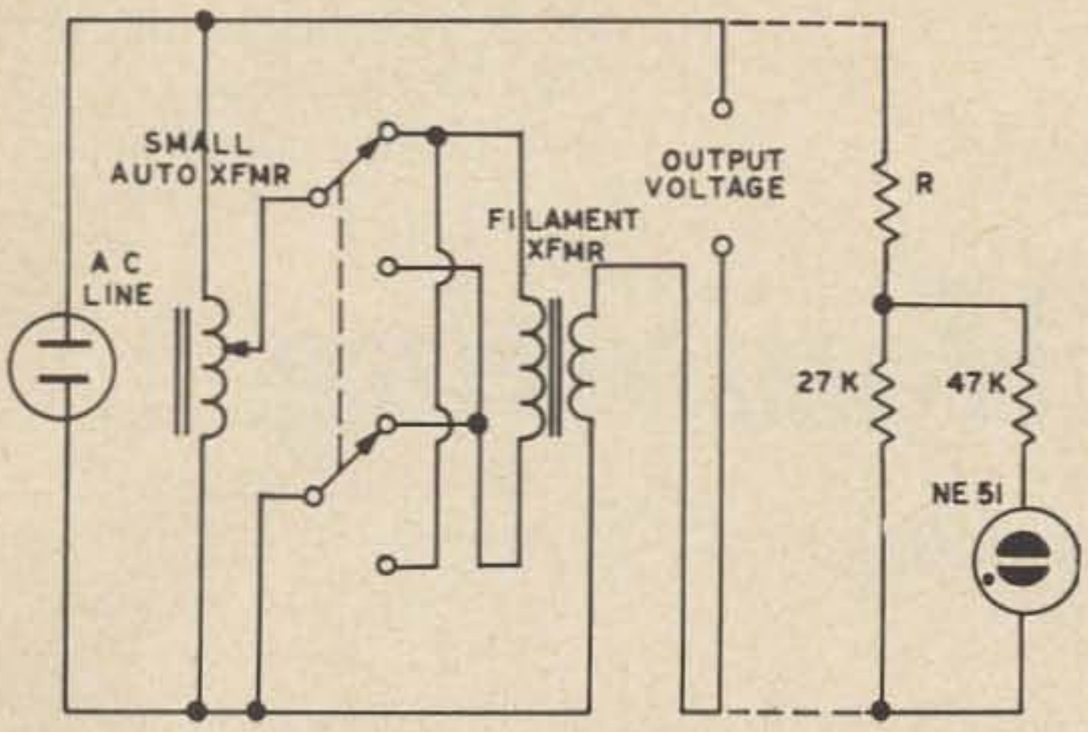

Fig. 4. Variable "Boost/Buck" system with neon bulb indicator. Adjust R so that bulb fires at desired voltage setting.

These methods of voltage control are very desirable in cases where load requirements are variable. They are much preferable to a series dropping resistor since, not only can they adjust up or down, they consume very little real power and only slightly affect voltage regulation.

Reference

1 Kyle, An AC Voltbox, 73, October 1966.

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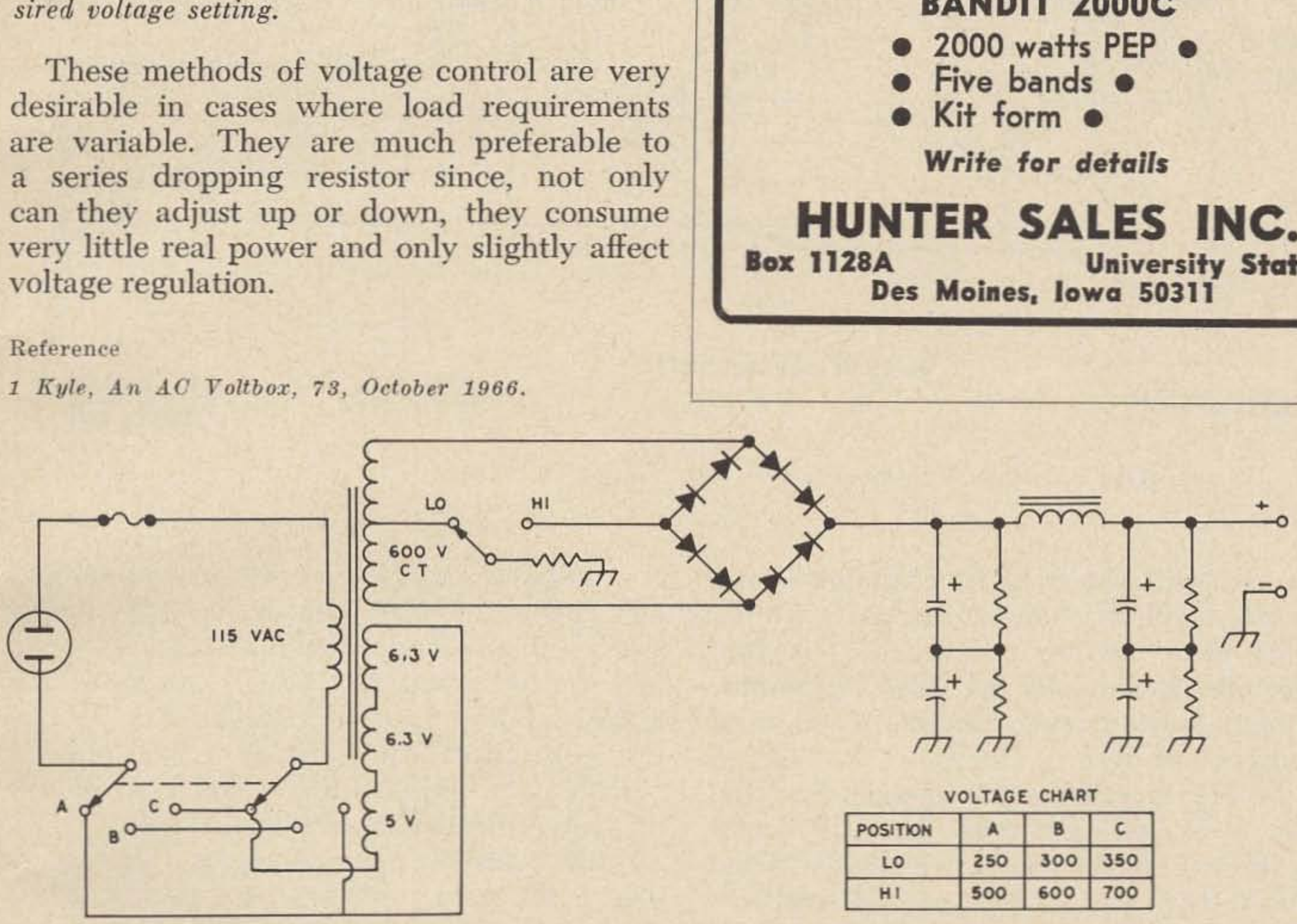

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Fig. 5. Flexible dc plate supply using a TV power transformer with multiple filament windings.

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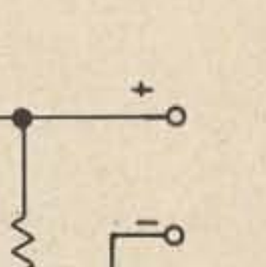

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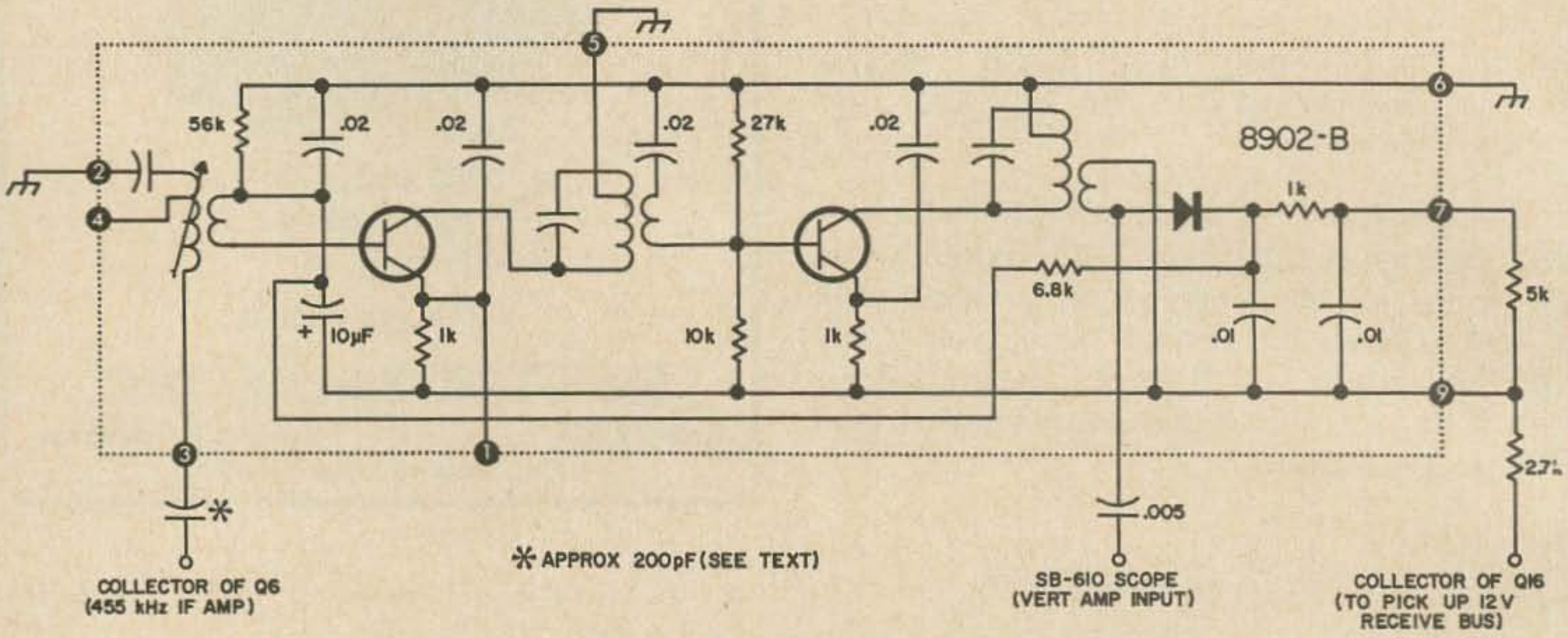

Fig. 1. The pre-wired circuit of The module.

The Heathkit Model SB-610 Monitor Scope is a convenient instrument for use with an amateur radio station to monitor "on-the-air" signals. It can also be used to monitor radio signals from other stations when used in conjunction with a receiver . . . or so says the Heath instrument manual. And the statement is certainly true; also, as easily accomplished as the manual indicates when the application is to a vacuum tube receiver's *if* strip. Try it with a solid state receiver or transceiver, and the cheese gets a little more binding, as they say!

Conventionally, receiver monitoring connections are made to either the grid or plate circuit of the last *if* stage in the receiver, using the smallest value of coupling capacitor that will give adequate pattern height. In this manner a portion of the signal is sampled and coupled through the vertical input jack of the scope to the vertical amplifier. In the cost of the SB-610 this is a vacuum tube stage employing a 6EW6. The input resistance is 100k ohms.

When the application is to a transistorized *if* stage with its lower signal level and lower impedance, the resultant picture on the scope is totally unsatisfactory. If the attempted pick up is at 455 kHz *if*, a very simple and inexpensive solution lies at hand . . . a tiny transistorized *if* module known as the 8902-B, put out by the Miller coil people. For only $3.75 this little gem will provide 55 dB gain. Bandwidth is 8kHz at 6 dB; dc requirements only 2 mils at 6 volts.

With various manufacturers hinting at new solid state receivers or transceivers on the horizon, the 8902-B may be a very handy gadget to know about. Right now any owner of an SBE 34 or 33 transceiver who has ever attempted to monitor received signals on an SB-610 has quickly found out it just won't work . . . at least, not without modification. But the Miller 8902-B module provides a made to order solution.

Fig. 1 illustrates the pre-wired circuit of the module and a typical application between a transistorized *if* stage and the Heath Monitor Scope, using the SB-34 as an example. The small size of the 8902-B lends itself beautifully to mounting under the circuit board at the left rear corner of the chassis. (See **Fig 2** for a simple method of mounting via a lightweight metal mount-

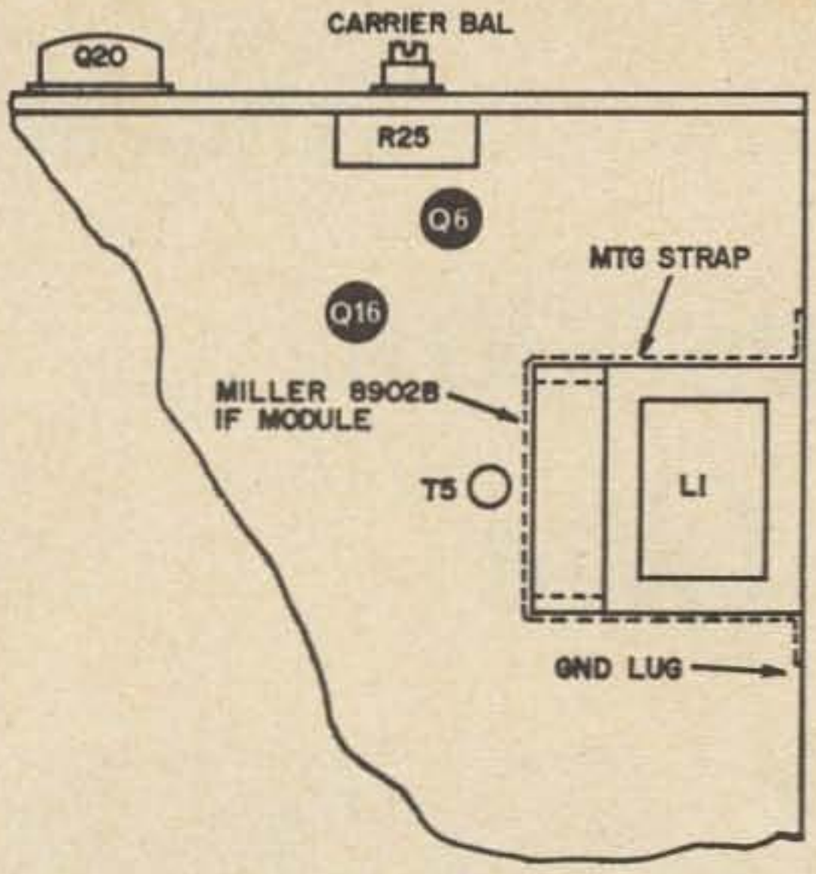

Fig. 2. Simple Mounting Method.

ing strap clamped under the existing screwed in mounting feet for audio choke L-1) This will place the module in colse proximity to the pick-up point for *if* input as well as for dc power.

Coupling to the receiver circuit is accomplished at a point under the circuit board where the collector of the 456 kHz *if* amplifier Q-6 is connected to the high side of the receive path input winding of 456 kHz if coupling transformer T-2. Fairly heavy coupling (200 $\mu\mu$F or so) is required if maximum picture height is desired. It is possible to obtain this however, and compenusate for the detuning eect by retuning the slug of T-2 for maximum audio signal by ear . . . on a received monitored signal . . . or maximum transmitter output on a two tone test. When you're all through make sure any retuning of T-2 has not upset the corret setting of the carrier balance pot.

Many of today's transceivers (whether solid state or not) make use of bilateral stages that must do double duty, functioning on both receive and transmit path. This must be taken into consideration when attempting to use the Heathkit Monitor Scope. A bilateral *if* stage would continue to provide a signal on transmit. This would be applied to the vertical amplifier of the SB-610, superimposing a signal on top of the energy being picked up from your own transmitter for the monitoring of your own *rf* output.

Here again the 8902-B strip provides an easy does it out when applied to any transceiver with a keyed voltage bus on receive. The solid state switching of an SBE-33 or 34 does this by providing a plus 12 volt bus from the collector of switching transistor Q-16 in the receive mode. The same point is at ground potential during transit, effectively killing the passage of a 456 kHz *if* signal through the little Miller module.

Terminal 7 of the 8902-B normally supplis audio output where required in receiver building block type applications. For the monitoring application described in this article the unit is easily modified as indicated by the *rf* output lead shown in **Fig. 2.** A new terminal is created for this lead by bringing out a small wire from the input side of the diode. This may be threaded through a small vacant hole that exists in the phenolic baseboard of the module between active terminals 7 and 9.

Go ahead . . . try it. You'll add new meaning to the words, "Here's looking at you"!

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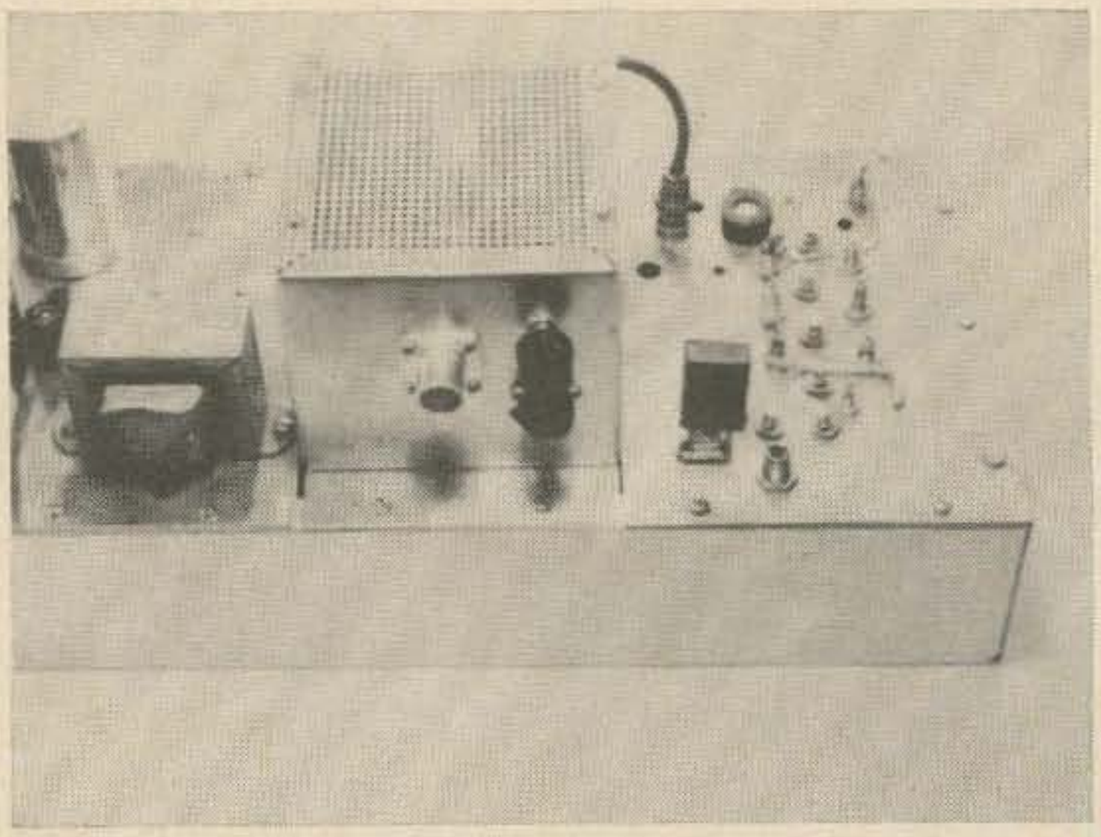
The 2 Meter Transistor Transmitter Plus One

With the present popularity of both 6M and 2M FM, the cry for more up to date equipment has been heard. Here, in part, is the answer to that cry—a transistor 2 meter FM transmitter which meets all the desired requirements: narrow band, size, efficiency, power, and most of all reliability.

The basic circuit was more or less a copy of the 250 mw transmitter circuit which appeared in the T. I. Dalcom Booklet. Unfortunately, 250 mw is not of much use, that is unless you want a walkie talkie. With the addition of the 2N3866, a power of 2.5 watts can be obtained without too much trouble. The 2.5 watts can be used to drive most any tube circuits in the 100 watts range.



The circuit

Basically the circuit is an oscillator followed by a phase modulator, 3 triplers and 4 class C amplifier stages. The power supplies are simple series regulators from a common source and a standard full wave rectifier for the high voltage.

The oscillator Q1 is a Pierce with L1 tuned to the oscillator frequency. The 33 pF capacitor from the base to ground can be variable for frequency adjustment. Some frequency pulling was noted in tuning L1.

The phase modulator is fairly straight forward. Here an ordinary AM signal is combined with a somewhat larger unmodulated carrier which is shifted in phase by 90° from the phase of the carrier in the AM signal. The resultant signal then varies in phase with the modulation. The 6.8 pF capacitor produces the required 90° phase shift while Q2 acts as the control device. The two signals are added vectorially at the collector of Q2. About 2.0 volts RMS is all that is required to give ± 5 KHz deviation at 144 MHz.

The next three stages of Q3, Q4, and Q5 are triplers which are tuned to 16 MHz, 48 MHz, and 144 MHz respectively. Q5 has an output of only a few mW which is then coupled into Q6. The output of Q6, which is a class C amplifier, is coupled by way of a 15 pF capacitor and the two 270 ohm resistors 1000 pF capacitors to Q7 and Q8. These stages have separate bias resistor and emitter resistor to help compensate for any unbalance in the dc and beta between the two units. The output here is around 250 mW to 300 mW which is coupled through the 25 pF variable capacitor to the base of the 2N3866. The 2N3866 is tuned by way of the 30 pF variable, L7, the six inches of RG-58 and L 8.

The final is a 6146 which like the other stages is operated class C. Neutralization is accomplished by use of the modified Z235. Series tuned circuits are used in the grid and the plate circuits for maximum efficiency. The output is around 35 watts with 400 volts on the plate.

The power supply shown in **Fig. 2** for the transistor stage is full wave bridge and a simple series regulator using surplus 2N1050's or any other NPN med. power transistor. The plus 28 volts supply used

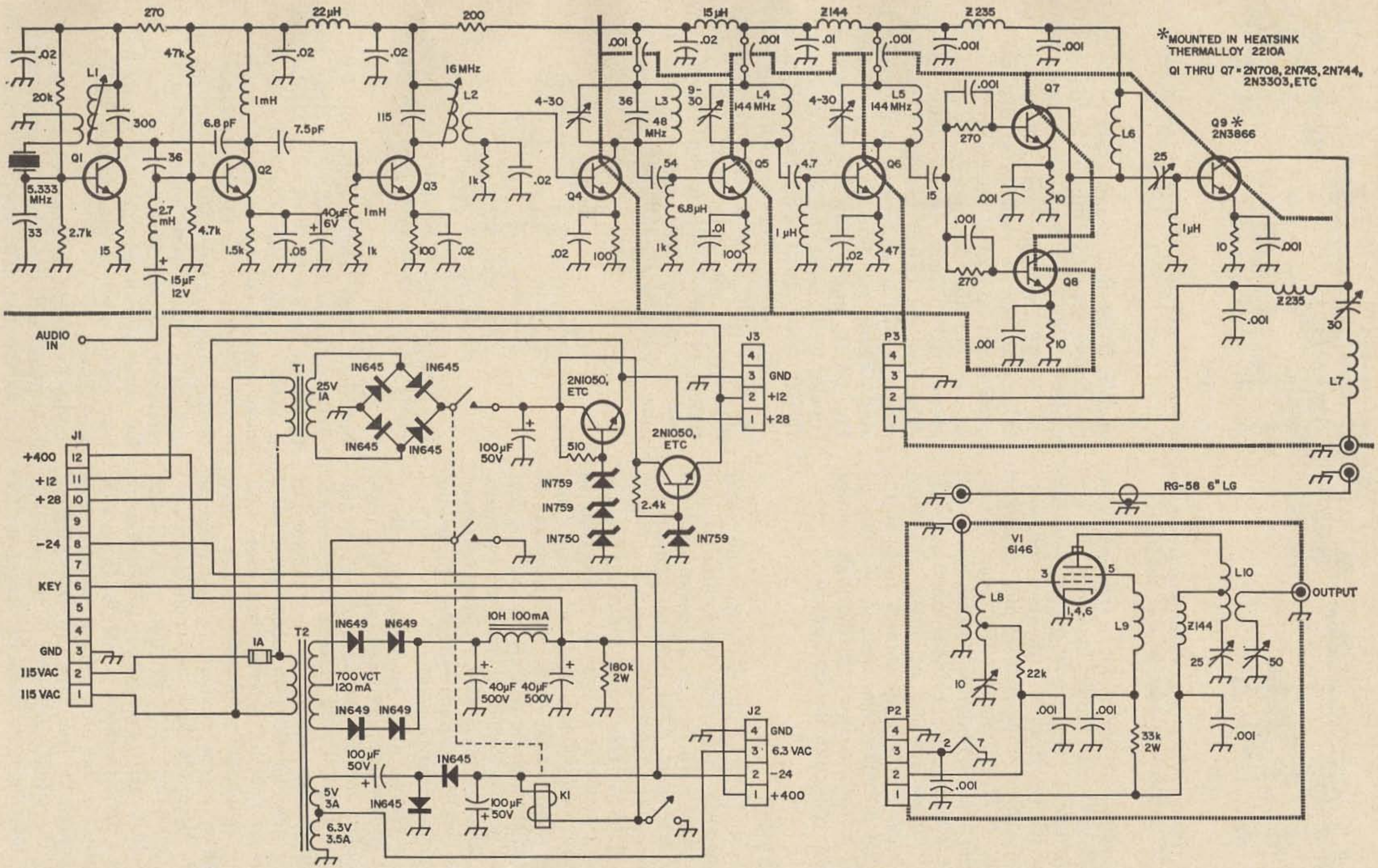


Fig. 1. Schematic diagram for the "Two meter transmitter plus one" with power supply for the transistor stage.

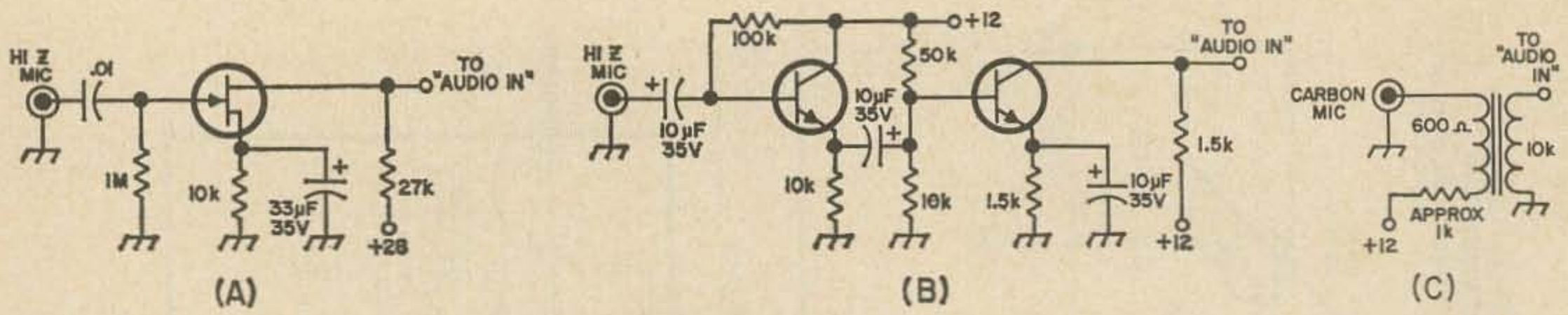


Fig. 2. Three audio preamp methods depending on the type of mike used. C is for a carbon mike, and either A or B may be used for a crystal mike.

three zeners in series for a reference but one 28 volt zener could be used. The output voltage is: zener voltage—0.6 volt. The supply for the 6146 is a standard full wave with a π filter using two 40 mfd capacitors and a 10 Henry choke. The relay voltage and the bias is obtained putting the 5 and 6 volt winding on the transformer and half wave voltage doubler in series. The fixed bias is not really high enough to hold the tube but is better than none at all. The relay K1 is used to key both the high voltage and low voltage to the transmitter.

Construction

As can be seen in the photo, no effort was made to make the transmitter in any way compact. In fact, as a general rule, the layout has quite a bit of room. The transmitter exciter is constructed on a 5 x 7 inch sheet of brass. The reason for using brass is mainly because it is easy to work with in mounting components and in making the shields. Each stage, with the exception of the oscillator, phase modulator, and the first tripler, is constructed in its own compartment. The use of ¼ watt resistor, miniature chokes, and tantalum capacitor make the construction fairly roomy.

As a general rule, no parts are critical, except in the last few stages and here only the chokes and the coupling capacitor values, but I guess that doesn't leave much! The shields are used not only as shields but also to give locations to make *good short ground* connectons. Johnson miniature variables capacitors (160-130) were used throughout except in the base and collector of Q9. Here the base and collector capacitors are midget mica trimmers (ARCO 422 40 pF to 4 pF). The output is coupled by way of a six inch piece of RG-58. Here, and only here, is the only critical point in the construction of the unit. If the coax is longer, the ARCO Trimmer in the collector of Q9 may have to be a bit larger or L7 smaller. If the final is not going to be used, the circuit shown in **Fig. 4** can be used to match a 50 ohm load. As stated before the 33 pF capacitor from the base of Q1 to ground can be variable so that the frequency can be moved somewhat. The audio is fed into the transmitter by way of a phone jack. There is no audio preamp shown on the circuit in **Fig. 1** because it was unknown what type of mike would be used. There are three methods shown in **Fig. 2A, B,** and **C** any of which will work equally well. As to the transistors used, the 2N708 were used here, but others were tried and worked about as well. The 2N708 can be bought surplus for 2/$1 from Poly Paks or new for only $1.32. The "silect" version of the 2N708 is the TIS45 which sells for around $.60 new. The best transistor tried was the 2N2369 costing $2.40.

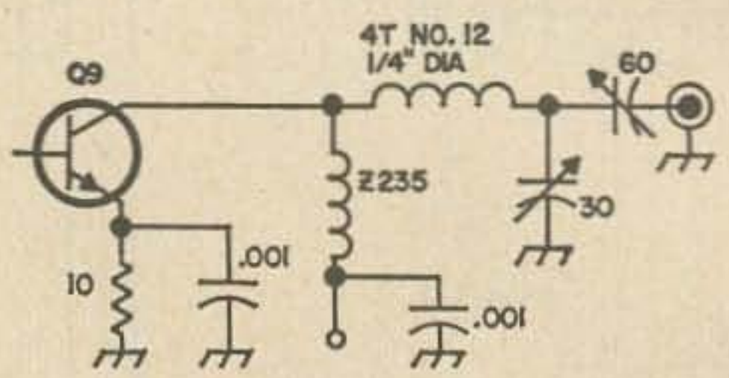


Fig. 3. If the final is not going to be used, this circuit can be used to match a 50 ohm load.

But the "silect" TIS48 costs only $.64. All things being equal the 2N708/TIS45 seems to be the best for my money. The 2N3866 is made by RCA and, to the best of my knowledge, it can not be bought surplus but is only $5.00 new. As for the transistors used in the audio preamplifier in **Fig. 3B** most any NPN would work with little or no difference at all. The FET amplifier in **Fig. 3A** has some advantage and may be preferred, here again most of the bargain FET's will work fine.

The 6146 final is constructed on a 4 x 7 inch plate and the 6146 is enclosed in a 4 x 4 inch box. The capacitor used in the

grid circuit is a Johnson Miniature (160-104). The grid coil is series tuned with the link tightly wound over the grid coil. The plate circuit is also tuned with the one turn link in the center of the coil. The transistor exciter and the 6146 final both have 4 pin male Jones connectors mounted on them so each can be removed with ease.

The power supply is mounted on an 8 x 7 inch plate. The low voltage regulator is constructed on a 3 x 2 inch piece of Vector Board. The transistor used in the low voltage regulator is any NPN medium power transistor with collector to emitter breakdown voltage of 50 volts or more. A 2N1050 was used here but any of the 2N1048, 49, 50 can be bought for a dollar or so surplus. The three units are mounted on a 7 x 17 inch chassis and a 12 pin male Jones connector is used for voltage output and keying.

Tune up

With the use of a GDO and rf indicator, such as a wattmeter, or wavemeter, the tune up is pretty simple. *Never operate the transistor exciter without a load.* If it is operated without a load the 2N3866 will be damaged. First tune L1 until the oscillator starts and shows maximum output on a wavemeter or a receiver. Next tune L2 through L9 for max rf output into the wattmeter or load. These will have to be repeaked a couple of times. The bias to the 6146 can be *removed* and a 0-5 mA meter can be used from the 22K resistor to ground to indicate grid current. With all stages peaked the grid current should be around 2.5 to 3.0 mA. The plate current should be around 150 mA at 400 volts. The screen voltage should be approximately 190 volts. The 28 volt current is around 125 mA; the 12 volt current is around 100 mA. The output was measured to be 36 watts but will vary somewhat. No provisions were made for an audio preamplifier. If a carbon mike is used, use **Fig 3C**; and **Fig. 3A** or **B** for a crystal or ceramic mike. The unit here is being used on 143.950 MHz MARS.

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The Yasme World-Wide DX-peditions

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YASME II, symbolically displaying "DX-73" on its main sail.

The YASME World-Wide DX-peditions have given many a ham his first contact with a rare country during the last decade and a half of amateur radio. To some amateurs YASME means a ship; to others it stands for a mysterious group of rich amateurs; but to the majority of the amateurs of the world, it stands for DX. Everyone who has had anything to do with YASME has been interested in DX—that special activity within the wide scope of amateur radio which consists basically of holding two-way communication with as many different "countries" as possible. At this time, the top DX amateurs of the world have held two-way communication with some 345 different such countries. Some of the areas thus classified as countries consist of remote uninhabited islands and reefs; others are small countries with only one or two radio amateurs. A DX-pedition to such areas is the only way of permitting large numbers of hams to contact them. In addition, the DX-pedition serves the useful purpose of increasing interest and understanding of amateur radio in such remote areas and establishes approved licensing procedures.

From the beginning of ham radio, some radio amateur or group of amateurs have traveled to remote places specifically to set up a radio station so that other hams would have their first contact with that place. Until 1954, however, these trips or "DX-peditions" consisted of hams who made these trips for a weekend or at the most for a fairly limited period of time. The YASME DX-peditions are the first DX-peditions in the world to make such trips on a regular, continuing basis.

In 1954, a young Englishman, Danny Weil, built a small sailing boat in which he hoped to sail around the world. He named his boat "YASME" from a Japanese word meaning good luck. He had no previous sailing experience. He was not a radio amateur. He had only a small boat and a burning desire to conquer the world by sailing around it. After many difficulties, he finally sailed into St. Thomas, Virgin Islands, where he met Dick Spenceley, KV4AA. Dick talked Danny into becoming a ham and suggested to Danny that he go on a world-wide DX-pedition in his small boat and, at each rare spot visited, Danny go ashore and operate his amateur station. This is just what Danny did for the next nine years. All told,

he worked from 27 rare countries. During that period, Danny wrecked YASME I and YASME II and had innumerable exciting experiences—many of which he was lucky to come out of alive.

Danny married in 1960 and after a relatively short period of sailing together, Danny's wife told him that he must choose the DX-pedition or her. Danny chose married life and stopped his travels. Danny wrote a 1,000,000-word book on his many hundreds of thrilling incidents such as the following, written by Danny describing the disaster of YASME II which occurred immediately after he departed from St. Vincent Islands where he had operated around the clock for several days as VP2SW.

"The first grinding crash awoke me instantly. Massive seas broke over the stern, sweeping into the cockpit. For seconds nothing could be seen as the spray blinded me. The grinding and crashing of YASME on solid rock left me under no illusions as to what had happened. Jumping out of the cockpit, I threw the engine astern, opening the throttle wide. A mad rush along the decks to release the sails. As they tumbled onto the deck, I dashed back to the cockpit.

The wind was dead astern, forcing YASME further and further onto the rocks. For seconds she would be afloat; then would come the heartrending crash as the mountainous seas picked her up and crashed her down on the unyielding rocks. How long she would accept this treatment was doubtful. I cast an anxious eye below, but saw no signs of water. Suspecting the worst, I stuck the engine bilge pump on, hoping I wouldn't need it.

The moon, where it had so recently shown peace and magnificence, now showed desolation and horror. Vicious black rocks appeared to surround YASME, as she founght for her life. Dead ahead rose a sheer cliff towering into the sky, acting as sentinel to its myrmidons of small fry. For those brief seconds I thought I had landed into a nightmare.

YASME trembled as the spinning propeller fought with the sea and wind to drag her clear. The interminable crashing and grating as nature strove to destroy her almost drove me insane. All my hopes were tied up in the engine.

Danny Weil operated from G7DW/mm, VP2VB, KZ5WD, FO8AN, VR1B, VK9TW, VR4AA, CR1OAB, YVØAB, VP2KF, VP2AY, VP2MX, VP2KFA, VP2DW, VP2LW, VP2SW, VP2GDW, VP4DW, VP7VB, VP5VB, HKØAA, HC8VB, ZK1BY, ZM6AW, VR2EO, FW8DW.

I kept looking at the rocks alongside. With each rise and fall of the seas, YASME moved an infinitesimal amount astern. Could it be possible she would get off under her own power? My body dripped sweat. I trembled like a leaf as I stood at the wheel leaning astern as though that alone would assist the creaming engine.

The first rock slid out of sight into the seething spray. For those few moments, my hopes rose. She was coming off slowly but surely. Something was amiss. An undercurrent of fear pushed itself up into my feelings of elation. I glanced quickly astern. A mountainous sea was roaring in. Its high breaking crest appeared as jagged white teeth as it swept in to engulf YASME in its maw. Petrified with fear, I gripped the steering wheel, unable to take my eyes from this monster.

Suddenly it struck. YASME rose into the air as though she were a matchbox. As it receded, she came down with her thirty tons dead weight. The wheel jerked itself from my hand. A demoniacal scream came from below as the gear box tore itself apart; then, the engine stopped.

The rudder had been smashed and jammed the propeller. A deathly silence pervaded, broken only by the breaking seas as YASME was swept back onto the rocks. Without power or steerage, she was helpless and I knew her time was limited.

With a superhuman effort, I threw the dinghy over the side. I wanted to get a

rope and anchor out astern to stop her slewing around broadside. As the dinghy struck the water, it was immediately swamped. Attempts to bail it out were futile. Several times I attempted to get into it, but the seas swept it from me. Within a few minutes, it started to fall apart, then it was gone. Only the painter tied to the rail and a small piece of timber hanging from the end proved there was actually a dinghy there at one time. As the oars floated away in the surf, my hopes vanished with them.

I ran below and fired up the rig. I had done my best to save YASME and now it was time to save me. Hanging onto the lurching cabin door, I anxiously awaited the warm-up period . . . . the seconds seemed like hours. It was tuned on 7 MHz and the band was wide open. I snatched up the mike and almost passed out. The entire rig was alive with 110 volts and I was standing in a foot of water. YASME was holed.

I had a choice. Drowning or electrocution. YASME was taking water fast. I stood there fascinated. I could hear many of my friends talking. Any one of them could have organized aid in a few seconds. The transmitter was working and I couldn't even switch it on. What an ironical position to be in!

I hated the thought, but had to accept the fact that YASME was finished. I cursed myself for being all sorts of a fool,

Lloyd Colvin, W6KG, and Iris Colvin, W6DOD, operated from KG6SZ, W6KG/KG6, KC6SZ, KG6SZ/KC6, KX6SZ, VR1Z, GD5ACH/W6KG, GD5ACI/WB6QEP, GC5ACI/WB6QEP, GC5ACH/W6KG, ZB2AX, CT3AU, CT2YA, 6W8CD, 5T5KG, ZD3I, 9LIKG, 5L2KG, TY2KG, 5V1KG, 9G1KG, TU2CA. (photo by EL2NA).

Dick McKercher, WØMLY, operated from WØMLY/TJ8, /TL8, /TN8, /TZ8, /TR8, TY2MY, 5V4MY.

but realized that recriminations wouldn't help. I had to act. I had to do something . . . but what?

I clambered out on deck and watched YASME being forced high onto the rocks. Every crash bit deep into my body like a knife being inserted and twisted. I wanted to scream and pray to God. I wanted to jump overboard and pull her off with my bare hands. To stand there and do nothing drove me frantic and made me feel life just wasn't worth living. I thought of all the work, worry and effort that had made the expedition. All of it wasted through my utter stupidity.

I was ready to give up. It seemed pointless to save even a tube. Without YASME, I was finished, and yet, it seemed so utterly crazy to let all that gear be lost. The old brain box started clicking into high gear, and I thought hard and fast. Moving along the lurching deck to the bow, it appeared I could get ashore with slight difficulty. There were many large rocks partially covered which might be used as stepping stones to the beach. I swung

over the bow, my feet fumbling for a foothold. With the jerking and swaying of the boat, coupled with surging seas, it proved an impossible task. I tried to pull myself up. My body hanging full length was too heavy. My strength was gone. I had little alternative but to drop into the water and hope for the best. It was a rough decision to make but there was no choice. With a prayer on my lips, I let go. I tried to time the drop to coincide with a receding sea, but nature played one of her dirty tricks on me and a double wave came in when it should have been going out and picked me up like a matchstick. For a few seconds, I was completely submerged as I rolled in with the wave. I expected to feel the cruel bite of the rocks any moment and knew my chances were 99 to 1 against survival in that maelstrom of angry water. Strangely enough, I felt nothing. My head broke water and I struck out shoreward, wondering all the time if I was doing the right thing. Guess I was going to have to meet up with those rocks sometime and it may as well be now, as I was pretty weak and couldn't hold out much longer.

Seems we all get that little extra strength in times of need. I found myself a big rock and, swimming to its lea, managed to climb its rough sides with little damage other than minor abrasions. From this vantage point, I was able to make a complete survey. The actual shore was twenty feet from me. Timing my dive right, I did reach the shore O.K. My prayers were surely answered, and I thanked God to be on dry land and safe."

To help obtain funds to get another boat and new radio equipment for Danny after experiences such as just described, a group of influential hams interested in DX founded the YASME FOUNDATION in 1960. This is a nonprofit foundation and qualifies as an organization to which tax-deductable donations may be made.

In 1962 the YASME Foundation also sponsored a highly successful DX-pedition by Dick McKercher, WØMLY, to seven rare countries in Africa.

The YASME DX-peditions so far mentioned were conducted on the basis that amateurs worked were urged to make a small contribution with their QSLs to help defray a portion of the costs. This was, and still is, a highly controversial subject. Some amateurs feel no one in amateur radio should ever send money to help a DX-pedition, while others feel a small donation is more than justified. In any case, the Directors of YASME found that in order to keep DX-peditions such as Danny Weil's going they had to put a lot of their own money into the Foundation. This became a discouraging and expensive procedure and the Directors decided to let the YASME Foundation become dormant unless someone wanted to pay their own way on a DX-pedition and let the YASME Foundation help in other ways than direct financial responsibility.

In 1965, Lloyd Colvin, W6KG, and Iris Colvin, W6DOD, retired from business and went on a sustained DX-pedition under sponsorship of the YASME Foundation. All travel and equipment expenses were paid by Lloyd and Iris, with the YASME Foundation taking care of QSLing and publicity.

During 1965, 1966, and 1967, Lloyd and Iris traveled around the world, primarily by commercial aircraft, and worked from 22 rare countries.

Lloyd and Iris, after some two and one-half years of continuous travel, have decided to stop doing it on a full-time basis. They may, however, make occasional short-period DX-peditions under YASME sponsorship.

During the DX-peditions made by Lloyd and Iris, some donations have been received by the YASME Foundation. About half of the money so received has been used on QSLing expenses. The balance is held by the YASME Foundation which wishes to announce to the radio amateurs of the world that their donations will be spent for equipment in accordance with the following resolution passed by the Board of Directors of YASME:

"IT IS RESOLVED that the Treasurer be authorized to purchase radio equipment from cash on hand and that said equipment will be loaned to amateurs approved by the Foundation who are going on DX-peditions, and who agree that the confirmation cards, or QSLs issued for contacts with said DX-peditions will give printed acknowledgment to YASME FOUNDATION for supplying the equipment used, and further providing that said amateurs using said equipment will first sign a written agreement to return

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said equipment immediately upon completion of the DX-pedition in good condition, reasonable wear and tear excepted."

Anyone desiring to use such equipment for a DX-pedition, under the sponsorship of the YASME Foundation, is invited to write to the Foundation.

This article would not be complete without paying tribute to the Directors of the YASME Foundation, most of whom have been associated with it since the early DX-peditions made by Danny Weil, and all of whom have devoted much time, energy and money to further DX. The present Directors are Danny Weil (now a U.S. citizen, living in Texas); Bob Vallio, W6RGG (QSL manager and the hardest working man in the organization); Tom Taermina, WA5LES (publicity director and Editor of the West Gulf DX Bulletin); Ed Peck, W6LDD; Charles Biddle, W6GN; Golden Fuller, W8EWS; Hal Sears, K5JLQ; Jack Drudge-Coates, G2DC; and Dick Spenceley, KV4AA.

SAMS Books

People working in the electronics field appreciate its very great complexity, and usually spend some time learning more about the fundamentals and the technology. And the field is changing all the time, so that what is basic one year may be outdated the next.

Good study material is always valuable and may serve as a very useful advancement tool, also. Here is an example. Sams has just published a four volume set of books on transistor fundamentals. Their set covers the whole range from basic ideas (which should be reviewed, and not too rarely), through special circuits.

The four books are titled *Basic Semiconductors and Circuit Principles, Basic Transistor Circuits, Electronic Equipment Circuits*, and finally *Digital and Special Circuits.* This arrangement is something like a large novel in four volumes, in which you must start at the beginning to understand what it's all about.

Look for these and other SAMS books in your local amateur radio or other electronics oriented store. Or you can get them direct from SAMS at $4.50 each or $15.95 for the set.

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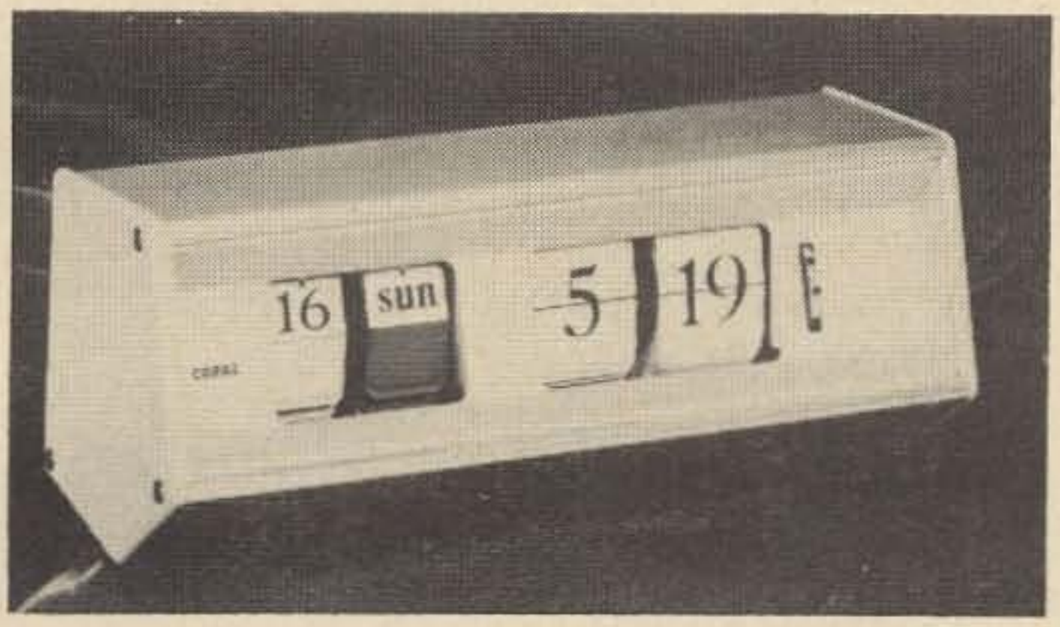

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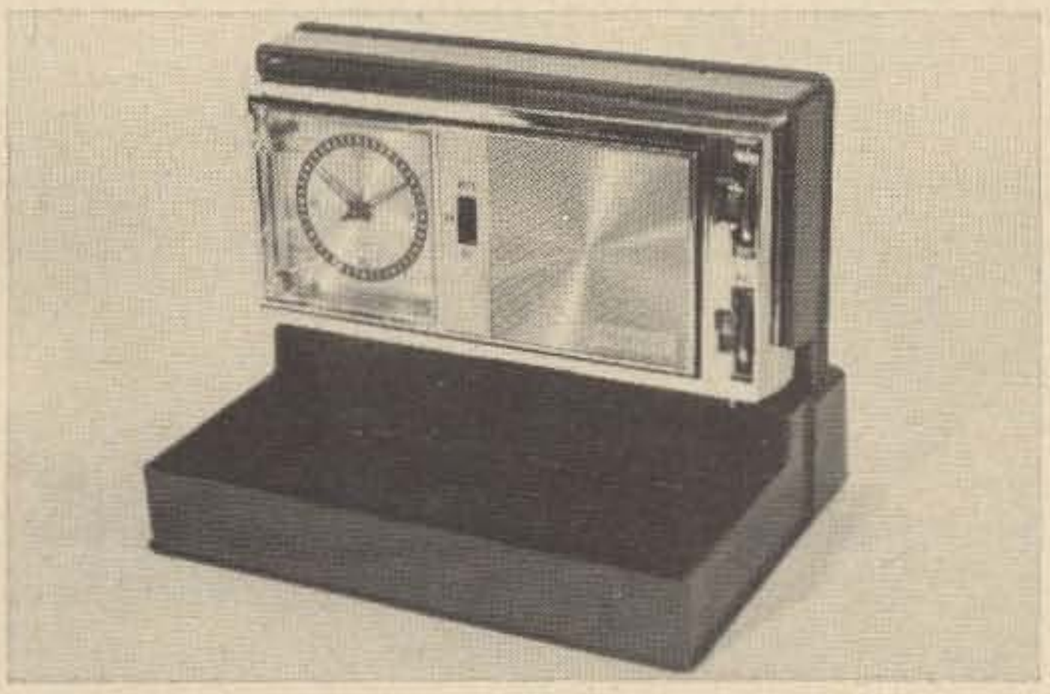

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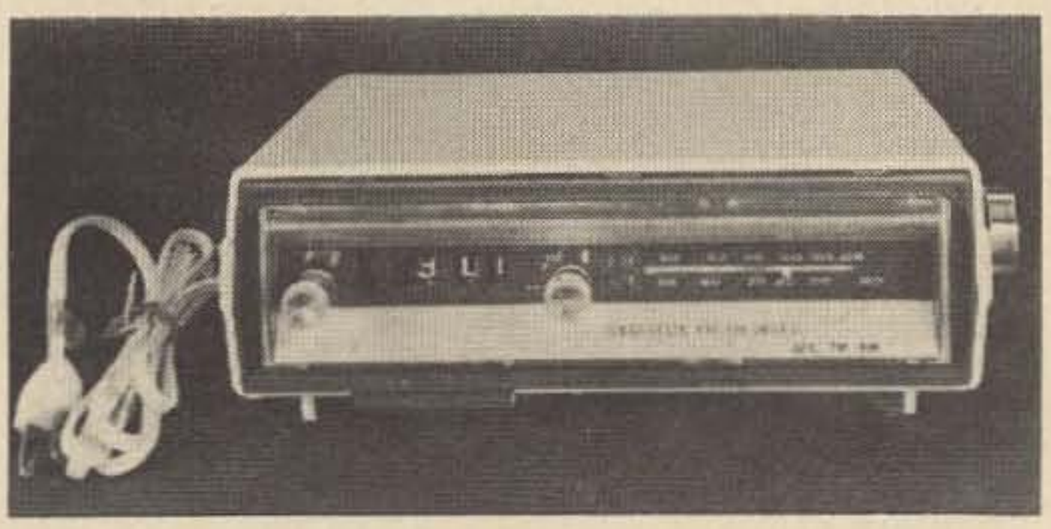

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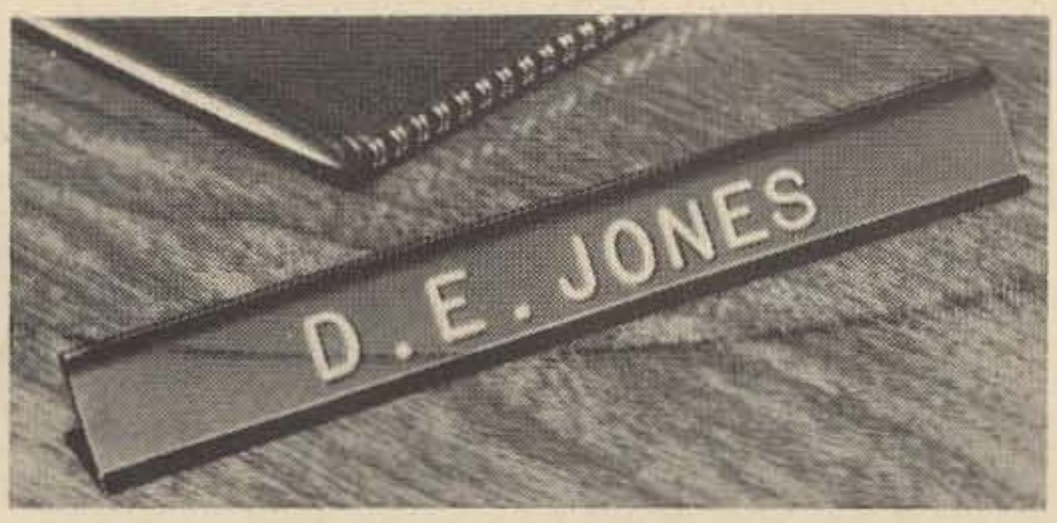

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The LC Power Reducer

John Schultz W2EEY/1
40 Rossie St.
Mystic, Conn. 06355

Reducing the power output of a transmitter or exciter while still having it work into the same load conditions as under full power output is usually accomplished by means of relatively expensive resistor T networks. This article presents a simple LC network which will much more economically accomplish the same purpose. Its operation has been proved by extensive usage in the broadcast field for high-power transmitters.

There are many reasons why one may wish to reduce the power output of a transmitter or exciter: for test purposes, to provide the proper drive level for high-power linears, to reduce QRM by using only the power required for a QSO, etc. The circuit described in this article affords a simple method to provide almost any desired degree of power reduction on any single amateur band. Perhaps the most outstanding feature of the circuit is that it uses only one resistor—a 50 ohm unit (for 50 ohm coaxial lines) which may, in fact, be the regular station dummy load. Therefore, no special high-wattage, non-inductive resistors of odd values are necessary as with conventional resistor-network power reducers. Not only are such resistors generally expensive and difficult to find, but they allow only one fixed value of power reduction. Certainly, they represent a very expensive item when a power reducer is desired only for occasional test purposes.

The circuit described in this article is certainly not new and no claims are made in that direction. Broadcasters will recognize the circuit as one which has frequently been used to reduce the output of high-power broadcast transmitters. It has not, however, received any usage by radio amateurs, probably because it was developed before the advent of high-gain, high-power linears required many amateurs to reduce the output and load conditions of the final stage as though the exciter were operating at full power output.

Basic Circuit

Fig. 1 shows the basic circuit of the

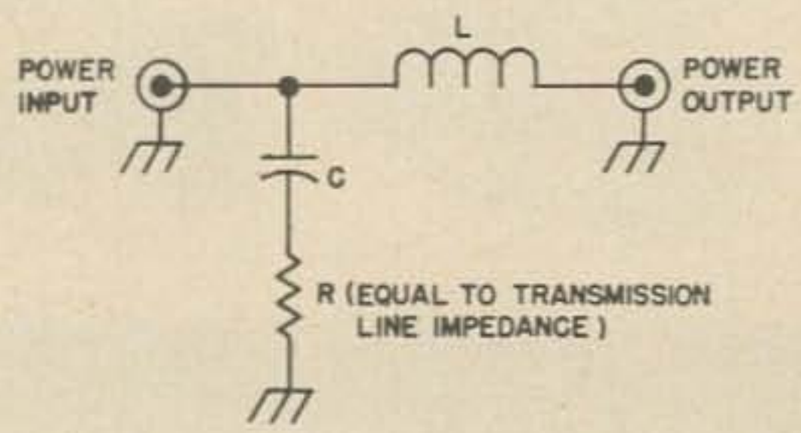

Fig. 1 Basic circuit of the LC power reducer.

power reducer. The two reactances form a power divider and the ratio of their values determines how much of the input power flows into the dummy load and how much power flows into the output load. When the dummy load and the output load are both 50 ohms, the input impedance will remain a constant 50 ohms regardless of which power reduction ratio the reactive elements are set up to accomplish. If the circuit is redrawn, as in **Fig. 2,** its operation may be clearer. At any particular frequency, the circuit is that of a simple voltage divider network. Note that since both the dummy load and actual load resistances are equal, they can actually be interchanged. This feature will be found of value, as explained later, when reactance values which are also physically possible must be determined.

Circuit Value Calculation

The value of the dummy load resistor is simply equal to the value of the transmission line impedance being used, usually 50 or 70 ohms. The power rating of the resistor is simply determined by the power reduction the whole circuit is desgined to achieve. If the output of a 500 watt transmitter is desired to be reduced to 50 watts, for example, the dummy load resistor must, naturally, handle the surplus 450 watts.

The value of the reactive elements is determined from the following formulae (substitute 70 for the 50 values shown if a 70 ohm coaxial system is used instead of a 50 ohm system).

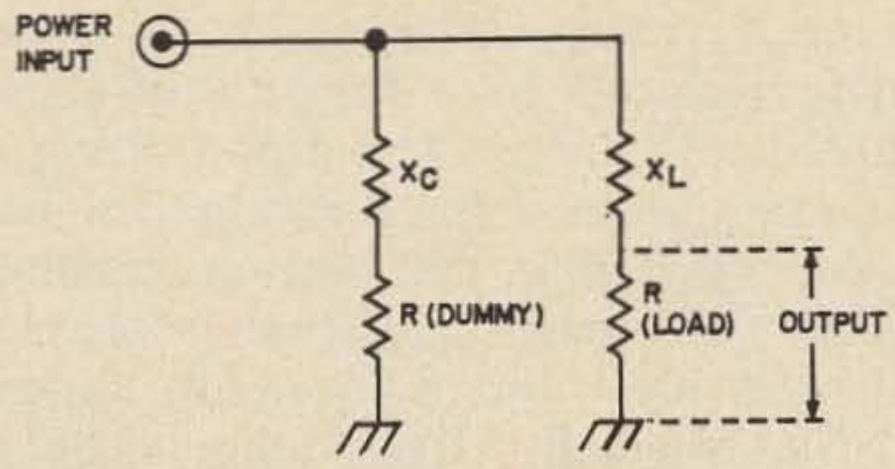

Fig. 2 The equivalent of Fig. 1 at any particular frequency is a simple divider network. Both resistances are the same value.

$$X \text{ (in series with dummy load)} = \frac{50}{\sqrt{\frac{P_{IN}}{P_{OUT}}}} \text{ ohms}$$

$$X \text{ (in series with output load)} = \sqrt{\frac{P_{IN}}{P_{OUT}}} \times 50 \text{ ohms}$$

Note that no signs are shown for the reactive values. The only criteria is that they be of opposite values but which one is capacitive and which is inductive is not theoretically important. An example should make this point clear.

Suppose it is desired to reduce the output of a transmitter from 500 to 50 watts, operating at 4 MHz and using 50 ohm transmission line. Then,

$$X \text{ (dummy)} = \frac{50}{\sqrt{\frac{500}{50}}} = 15 \text{ ohms}$$

$$X \text{ (output)} = \sqrt{\frac{500}{50}} \times 50 = 165 \text{ ohms}$$

If it is desired to use a capacitive reactance in the dummy load leg, one looks up from a handbook graph the value of capacitance producing 15 ohms at 4 MHz (or calculated from the formula ($pF = \frac{1590 \times 10^8}{f(Mc)\ X}$) which is 3,000 pF. The output leg must then contain an inductive reactance of 165 ohms at 4 MHz which is 5.4 μH.

$$L\mu H = \frac{159000X}{f(MHz)}).$$

If one were to reverse the reactances, their values have to be determined again (the actual capacitor and inductor cannot be simply exchanged). An inductor in the dummy load leg would have 15 ohms reactance and a value of 0.6 μH. The capacitor in the output leg would have 165 ohms reactance and a value of 250 pF. The two circuits which result from these calculations and which perform exactly the same degree of power reduction are shown in **Fig. 3.**

If the reader wants to check the calculation of the reactive values, another example would be the reduction of the power output of a 100 watt transmitter to 10 watts at 30 MHz. If a capacitor is used in the dummy load leg and an inductor in the output leg, the circuit values are 360 pF and 0.9 μH. If an inductor is used in the dummy load leg and a capacitor in the output leg, the values are .08 μH and 30 pF.

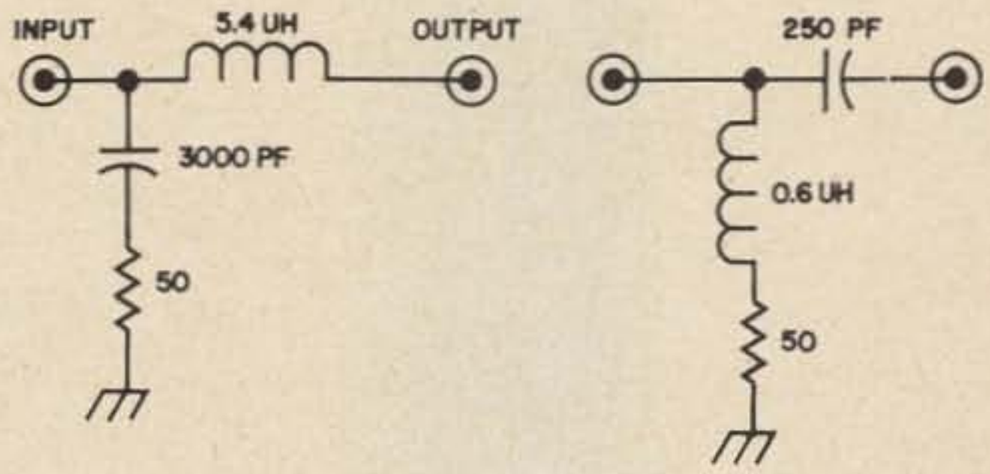

Fig. 3 Both circuits shown achieve a 10 to 1 power reduction ratio at 4 MHz. The method of determining the inductor and capacitor values is explained in the text.

Construction

Before a unit is constructed the reactive values necessary for both circuit options should be calculated in order to check which option fits parts on hand or is easier or cheaper to construct. For instance, if using new parts, the circuit of **Fig. 3(B)** would certainly be less expensive than that of **Fig. 3(A).** In the 30 MHz example given, the circuit option which produced an 0.9μH inductor would certainly be less critical to construct than that producing an 0.08 μH inductor.

No special construction methods are necessary and the components can be enclosed in a standard minibox. If the inductor is in the output leg, its wire size need only be appropriate for the amount of current produced by the output power in a 50 ohm line and results in a relatively inexpensive

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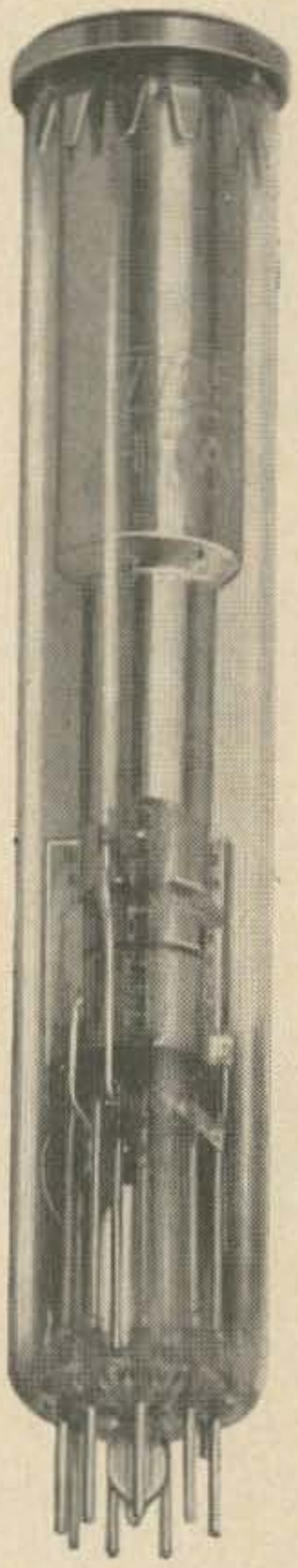

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inductor if a large amount of input power is being reduced to a low value. The capacitor should be a mica transmitting type and its minimum voltage rating can be determined by finding the current flowing because of the power dissipated in the leg in which it is used and then simply determining I^2Xc. Normally, the voltage rating will be quite low for even high powers but the current (rf) rating of the capacitor should also be checked with the manufacturer's rating.

Summary

The LC power reducer can be built and used in a number of versatile ways. Since it uses a standard dummy load resistor, it can be built as part of a dummy load. A tapped coil and variable or switched capacitor can be used if multi-band operation is desired. Or a variety of power reduction levels for one band, while maintaining constant transmitter loading, can be achieved using a variable inductor and capacitor. To achieve the same flexibility with purely resistor networks would require a very elaborate and expensive collection of switches and resistors indeed. . . . W2EEY

Amphenol's Color Commander Generator

Service oriented amateurs will be interested in Amphenol's new color bar generator. Priced at $139.50, it generates a set of nine assorted patterns for adjustment of centering, convergence, and other service controls of any color TV set.

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The Amphenol Color Commander contains an internal rf generator whose output is applied to the receiver's antenna terminals. Color sync and other circuits may be checked because the Color Commander uses a crystal oscillator with unijunction transistor countdown circuits for accuracy and stability. Operates from batteries or from an ac supply in the battery compartment.

For additional information on their Model 860 Color Commander, contact Amphenol Distributor Division, the Bunker-Ramo Corporation, 2875 South 25th Ave., Broadview, Ill. 60153.

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Why Ham RTTY

James L. Turrin WA8DCE
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The symbol "F-1" on authorized emission charts in FCC regulations may not mean much to some amateurs. To others it is an open door to an entirely different concept of communications. It signifies a technology which is challenging enough for the most learned engineer, yet basically simple enough for the greenest neophyte. This symbol "F-1", along with the symbols "A-1" and "A-2" authorizes amateur radio-teletype (commonly called RTTY) on all bands except 160 meters.

The word "Teletype" is actually the trademark of the leading manufacturer of teleprinter machines, the Teletype Corp. Over the years "teletype" has come to be a term used synonymously with "teleprinter" which is the actual descriptive name of the machine.

"Why Ham RTTY?", you ask, when we have CW, AM and SSB available to communicate with other amateurs in most countries throughout the world. The answer is simple. Amateur radio, by international agreement is designed as a service dedicated to furthering communications technology all over the world. It is a means of bringing together people from all walks of life, all races, creeds and religions who share a common interest, i.e. to communicate ideas and thoughts to each other. Amateur radio is also dedicated to furthering technical knowledge of many different means of communication by encouraging experimenting in these areas. This is commonly called "advancing the 'State of the Art'".

Amateur radio is made up of thousands of hardy individuals who are looking for a challenge or project just a little bit more difficult than the one they have just been involved in. These are your "experimenters" and "builders". These people, although not forsaking the old tried and proven ideas and modes of communication, are interested in new and different means of communicating. It is these people who look to the different areas of amateur activity such as Amateur Television. Facsimile, Slow Scan TV, FM, narrow band FM and Amateur RTTY for their enjoyment.

For many years, commercial telephone and telegraph companies have used teletype to transmit and receive printed messages from point to point in the U.S. and other countries. Teletype is a means of transmitting signals through wires from one teletype machine to another by the switching on and off of a dc voltage in a code pattern which the machine understands and converts to mechanical motion causing a type character to strike a sheet of paper thereby printing the message in directly readable form.

Amateur radio operators saw the opportunity to utilize another communication media when these machines came into use. The first problem they had to overcome was how to get the pulsing code signals from one machine to another. After trying various methods which worked crudely and only at times, these pioneers developed the process now called "Frequency Shift Keying" (FSK) or F-1 as termed by the FCC.

The FSK transmitting process is basically this: The transmitter is on the air and transmitting steadily at a given frequency called the "mark" frequency. When the desired character key on the teletype keyboard is depressed, a motor driven mechanism produces a switching off and on, in a code group assigned to the desired character, of a dc voltage. This voltage then activates an electronic unit which either directly or indirectly causes a reaction in the transmitter's frequency generating section which shifts the transmitted frequency very slightly for a period of about 22 milliseconds. It is this short period of frequency shift, when transmitted in code groups of the proper pattern, carries the teletype signal over the air. The frequency shift may be any value up to 900 Hz as allowed by FCC regulations. The most commonly used shift is 850 Hz although shifts as low as 170 Hz and 160 Hz are being used occasionally. This shifted frequency (generating the mark frequency minus 850 Hz) is called the "space" frequency.

A variation of the FSK which is authorized on high bands only (6 meters & up) is AFSK which means Audio Frequency Shift Keying. This method utilizes the constant carrier on action of either AM or FM but instead of a voice signal being transmitted, an audio tone of 2125 Hz is generated in an audio signal generator and shifted by the teletype machine 850 Hz to a tone of 2975 Hz. This audio signal is impressed upon the carrier frequency in the same manner that a normal voice signal would be transmitted. This system does not involve changing of the basic transmitting frequency as does the FSK system.

The receiving of RTTY signals requires receiving equipment of reasonable stability and selectivity. The incoming FSK signal is treated the same as a CW signal in that it is detected and changed to an audio signal by the BFO control on the receiver. The audio output to the speaker is tapped and some of this signal is fed to the RTTY converter. The converter amplifies these signals slightly and feeds the complete audio signal through two audio filters which only allow audio tones of a certain frequency to pass through them. These filters do not allow any other audio frequency to pass except the frequencies the filters are designed for. Usually these two audio frequencies are 2125 Hz and 2975 Hz. The BFO on the receiver is tuned until the steady audio tone coming from the receiver is 2975 Hz (mark freq.). This audio tone will pass through the "mark" filter. The frequency shift of 850 Hz will change the audio tone to 2125 Hz (the "space" freq.). This tone will pass through the "space" filter on the converter. These two audio tones are then amplified further and one or the other becomes the triggering pulse for an electronic switch which switches off and on the dc voltage in the proper sequence necessary to operate the teletype printing mechanism. The proper combination of off-on pulses of the dc voltage being fed to the printing unit then sets up the mechanical reaction necessary to print the proper character on the paper.

The equipment involved need not be expensive. In fact, by using an existing AM/CW transmitter (either crystal or VFO controlled) and the station receiver you already have, you can be on the air on RTTY for less than the cost of most SSB transmitters on the market today. The teletype machine itself will probably be the most expensive investment, costing anywhere from $20.00 and up, depending upon your source of supply. The RTTY converter can be either purchased commercially or home brewed from your junk box (or your buddy's) according to many schematics available today. The cost of this unit could run anywhere from $15.00 and up for a home brewed unit, to nearly $200.00 for an exotic commercially built version. The FSK unit generally must be designed and built to match whatever transmitter you are planning on using.

There are several good publications available today which carry schematics and construction details of converters, FSK units and other handy RTTY gear. These can be found listed in catalogs published by most electronic suppliers.

Ham RTTY is a service of high value in message handling and net activities. It is also a tremendously fascinating field which, as I stated before, can be challenging enough for the most experienced engineer yet basically simple enough that the newest ham can understand it.

This article was written, not to make RTTY experts of any of its readers, but, mainly to whet the readers' appetite to want to learn more about this fascinating phase of amateur radio. Amateur RTTY has its problems and frustrations just like the other modes but that is the real test of an amateur's dedication and zeal towards the goal he pursues; which is to advance the 'State of the Art'.

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Panadaptor or Spectrum Analyzer

Definition

A panadaptor, or radio-frequency spectrum analyzer, is a device which provides a panoramic display of the signal distribution in a selected portion of the radio-frequency band. The display takes the form of a plot of amplitude versus frequency, usually on the screen of a cathode ray oscilloscope.

History

Little work was done in the field of panoramic presentation of radio frequency spectra during the years preceeding World War II. However, the huge amount of organized research and development work in the field of microwave radar performed as part of the war effort caused a tremendous expansion in radio measurement techniques and measuring apparatus. At the Massachusetts Institution of Technology Radiation Laboratory, spectrum analyzers of various types were developed for use as test equipment in the design of pulsed oscillators for radar transmitters.

Although this first use of the spectrum analyzer was quite far removed from ham radio, it was not long before a ham decided this would be an extraordinary way of monitoring an entire ham band at a glance. Exactly when the first spectrum analyzer was used on the ham bands is not known to the author. The Hallicrafters Company, however, produced a commercial unit shortly after the war in early 1946. This was known as their model SP-44 Skyraider Panoramic. The unit was not widely accepted and was generally termed a worthless device and soon almost forgotten. The panadaptor did not become widely known again until 1965 when Heathkit introduced their Ham-scan Model HO-13. Today the basic operation is known to most all hams and some have learned to

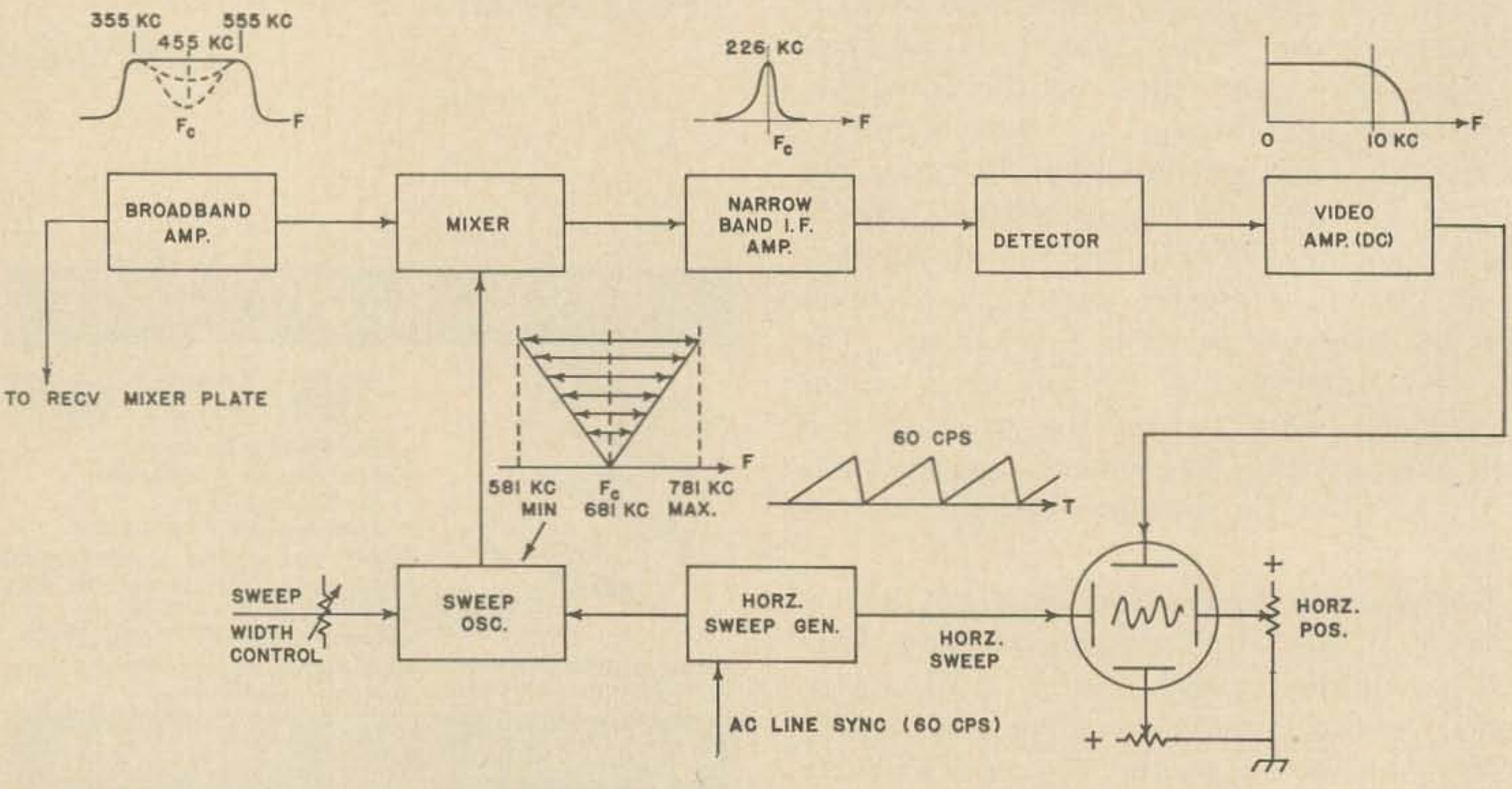

Fig. 1. Block Diagram of panadaptor spectrumanalyzer.

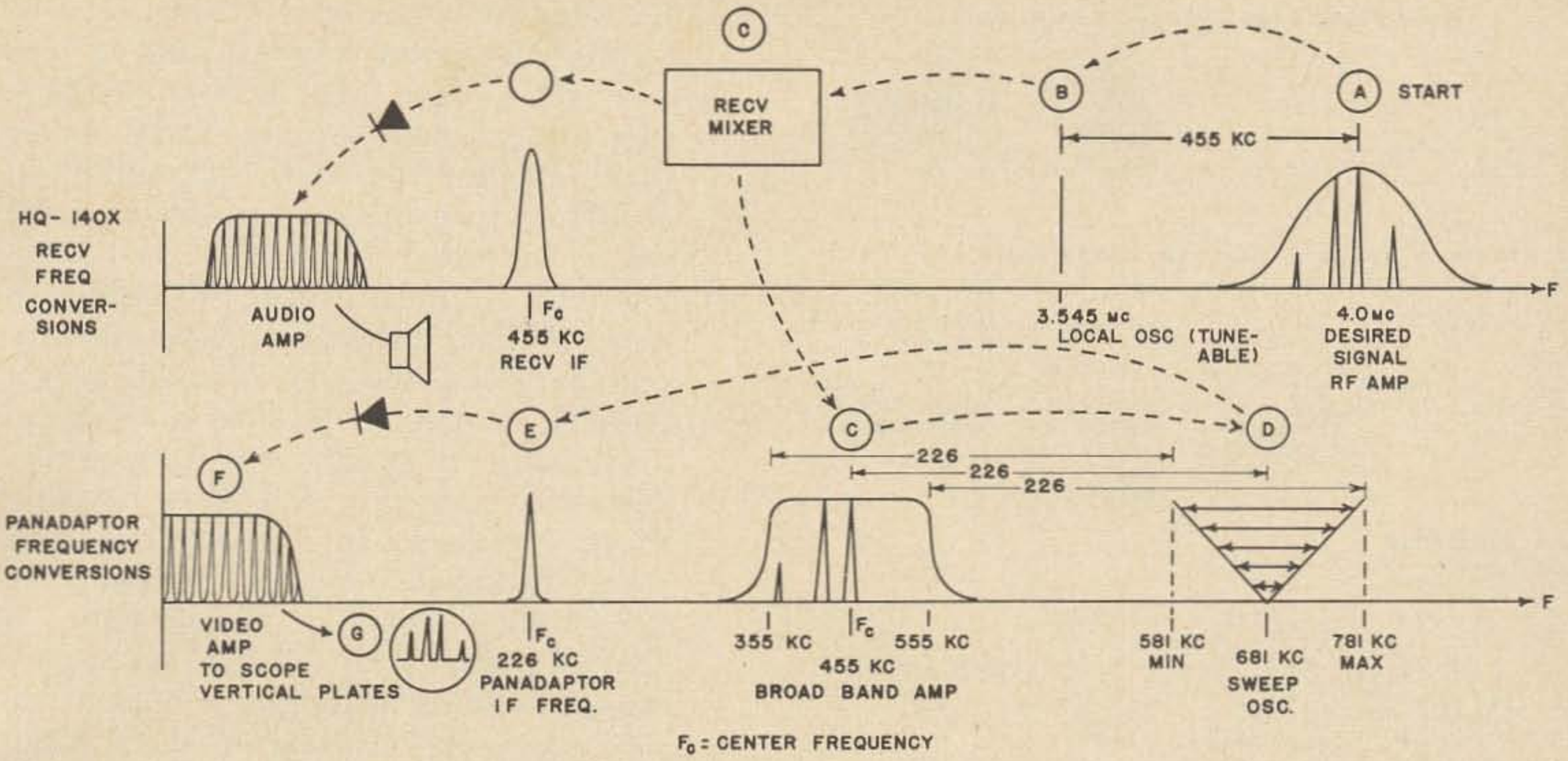

Fig. 2. Frequency conversions in a Panadaptor system.

A. Receiver rf amplifier showing broad band pass and four stations.

B. Receiver local oscillator displaced 455 kHz from desired station.

C. Here signal splits between receiver if *and to panadaptor broadband input amplifier.*

D. Variable sweep width FM oscillator mix with signals from broadband amplifier. Those with 226 kHz frequency difference pass on into panadaptor if *amplifier.*

E. Panadaptor if *amplifier band with sets resolution of system.*

F. if *signal rectified and audio components send to scope plates.*

G. Scope presentation shows stations as in A.

use it to great advantage in every day spectrum and signal analysis.

Operation

A spectrum analyzer is essentially a narrow-band superheterodyne receiver which is repeatedly swept in frequency over a selected portion of the radio-frequency band. At the same time, the horizontal deflection of the spot on a cathode ray tube moves in synchronism with the rf sweep. The vertical deflection of the spot is proportional to the output voltage of the receiver. The resultant display is a plot of amplitude versus frequency over the radio-frequency band of interest.

Fig. 1 illustrates a block diagram of a simple spectrum analyzer such as the Hallicrafters SP-44 and the Heathkit HO-13. This block diagram, of course, shows only the basic elements that are necessary to explain the operation of the analyzer. It can be seen from the block diagram, the primary deviation from a standard superheterodyne receiver is the horizontal sweep oscillator and a cathode-ray tube readout in place of the speaker. A careful study of this diagram and of the Frequency Conversions diagram (See **Fig. 2**) should illustrate basically how the panadaptor works. **Fig. 3** shows some typical wave forms which can be expected.

Uses

The panadaptor is best known for its abilities as described above, to provide a panoramic display of radio signals in a selected portion of the radio frequency spectrums. This first use is probably what caused a loss of interest in the device as one soon tires of only eavesdropping on the amateur bands. Only when you delve into the theory of the device, understand, and try to find new uses does it become useful. The following ideas are a few to which I have put mine to use:

1. Watch the stealthy spectrum pirate. He is the one who slyly tunes up on another frequency and then slides down 10 KHz to the frequency his buddies are on. You may also watch the band swoosher go by and track him to a frequency where he may finally identify himself.
2. Watch for band openings on the higher bands. With the receiver set in the

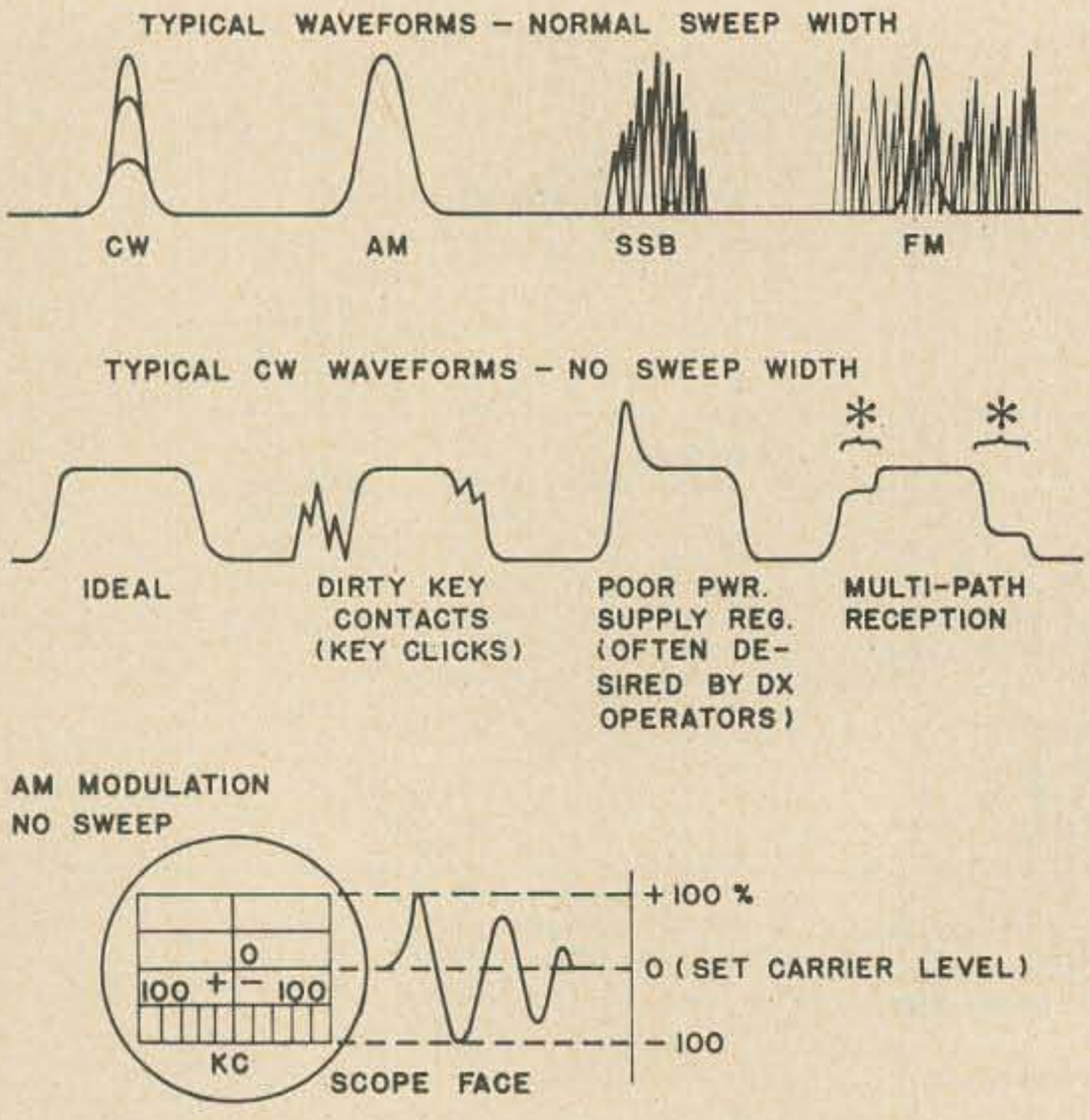

Fig. 3. Typical panadaptor wave forms.

middle of the 15, 10, or 6 meter band, watch for the signals to pop up.

3. Analyze modulation of other stations. Decrease the sweep-width to zero and you have a modulation analyzing oscilloscope. This will detect modulation percentage of AM and flat-topping of SSB.
4. Examine any mode signal (AM, CW, SSB) for spurious radiations–Splatter or parasitics have been quickly traced to the originating station with this device. (Take notice 00^{s}.)
5. Examine keying characteristics of CW stations–Drop the sweep-width to zero and watch. (See **Fig. 3**) You must be careful on distant stations on the lower band as they are very susceptible to multipath propagation and distortion of the waveform.
6. Examine characteristics of multipath reception and radio propagation in general by using the time domain reflectometry technique. In time domain reflectometry, a sharp front long period signal is sent out and the measurements are made by the effects of the reflected signal on the amplitude of the original signal. An example is shown in **Fig. 3** of the CW multi-path reception. This technique is opposed to the pulse-echo method used in radar where a sharp pulse is transmitted and the echo is awaited. Time domain reflectometry is practical in ham radio as the pulse may easily be generated by a "bug" or "automatic keyer" and does not take up valuable radio-spectrum. I have measured the virtual height of the "E" layer by this technique.
7. Find open spots in the bands for transmitting.
8. Monitor own transmitted signal through receiver–Check for modulation and spurious radiations.
9. Zero beat WWV with the 100 KHz calibrator.– By watching the "pulsations" of the waveform on the scope, it

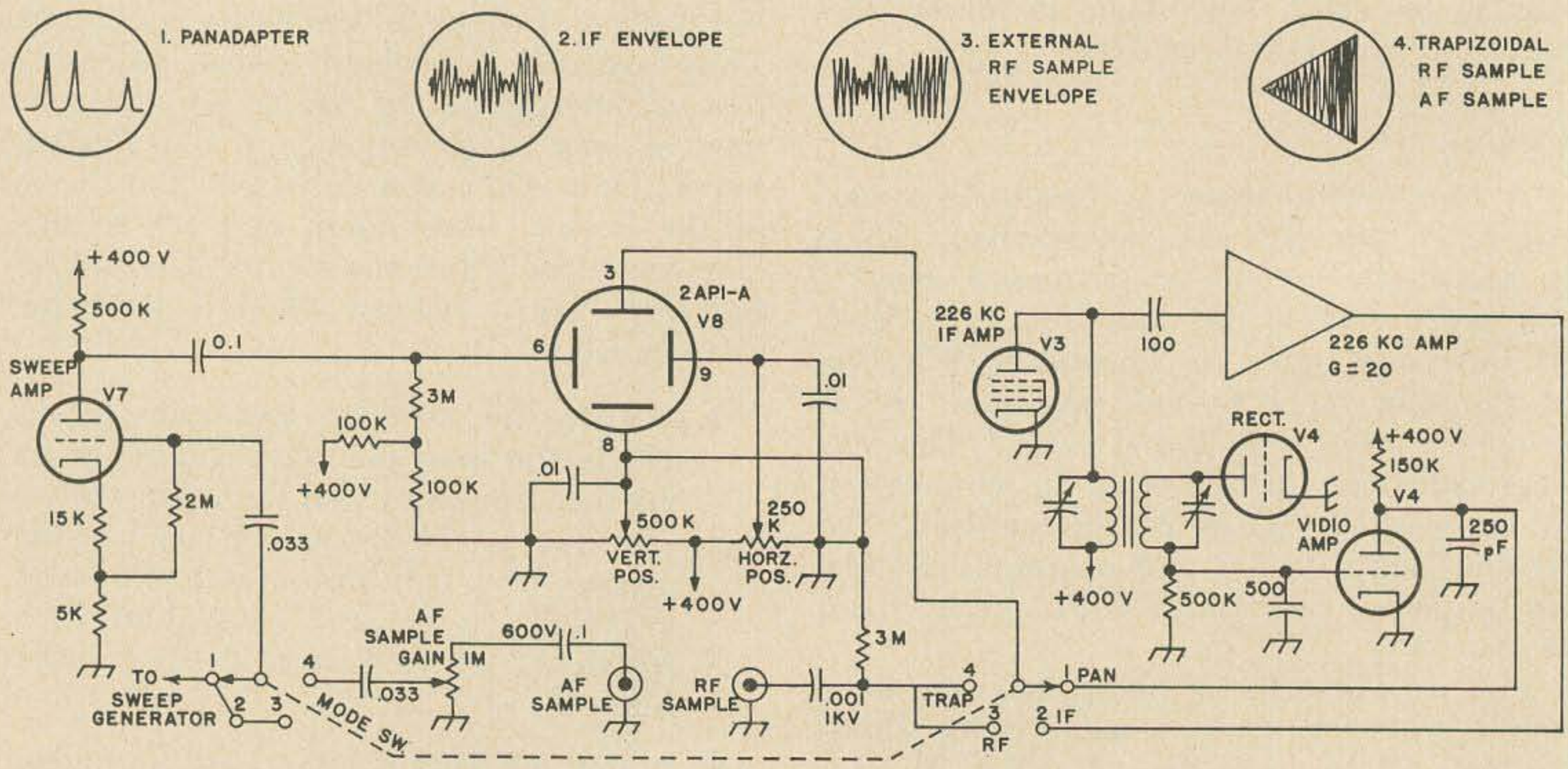

Fig. 4. C.R.T. Plate deflection circuits. Modified SP-44.

is possible to zero beat well below the audible beat. You may also check your own line frequency by watching the 600 Hz note on WWV. You'd be surprised how poor our 60 Hz line frequency is.

In addition to the nine described above, a modification to the panadaptor will add to the uses to which it may be put.

Modifications

On my Hallicrafters SP-44, I have made modifications to the circuits so the cathode-ray tube may be used for multi-purposes. A four position switch was added and the following uses were added to the panadaptor:

1. Normal panadaptor - standard uses as noted above.
2. *rf* Envelope presentation of panadaptor *if*.
3. *rf* Envelope presentation of external transmitter - A jack was added on rear apron for *rf* sample.
4. Trapezoidal pattern of external AM transmitter. A jack was added on rear apron for *af* sample. This switch position combines *rf* and *af* samples to give trapezoid pattern.

See **Fig. 4** for modifications to SP-44. These modifications were made only to the horizontal and vertical deflection plate circuits. Therefore, the modifications shown in **Fig. 4** only show those circuits driving the deflection plates. Any good handbook on ham radio and modulation techniques will describe what they can do for you.

Summary

I have found that the panadaptor is one of the most useful instruments that I have in my shack. In ham radio you normally use only one of your body senses in making contacts and that is the sound that impinges upon your ear. The panadaptor adds a second and that is sight. The ability to *see* as well as *hear* what is going on in a band adds a third dimension to amateur radio.

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2 METER
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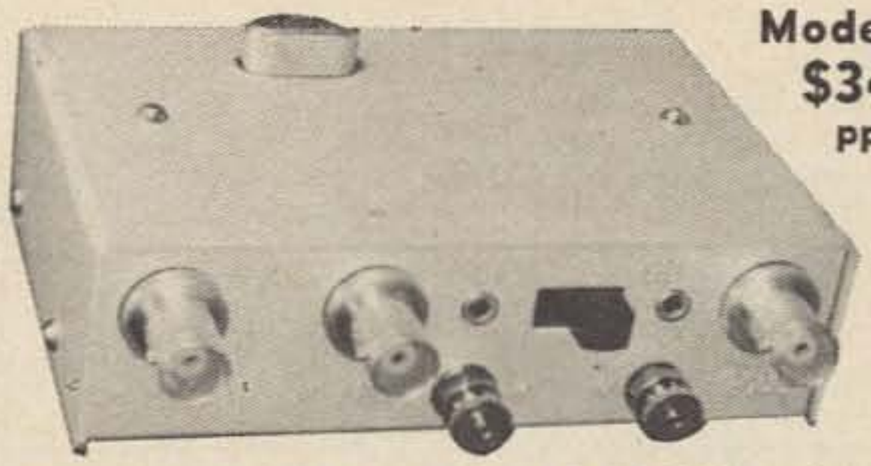

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VANGUARD LABS
Dept. H, 196-23 Jamaica Ave., Hollis, N.Y. 11423

The "Six Net"

John J. Sury W5JSN
3013 *Valerie Court*
Arlington, Texas 76010

Did you ever build a receiver that has sensitivity, selectivity and stability? In most cases one may have to be sacrificed for another. Here is a receiver that has all these features. The complete receiver is constructed on a 4 x 6 x 2 inch chassis and a 4¼ x 6 x ⅛ inch panel, including the ac power supply.

The receiver is a 10 transistor superhet which includes the 2 transistors in the Miller *if* strip. The *rf* section is a common base amplifier followed by a common emitter mixer. A special variable crystal oscillator and multiplier injects a signal 455 kHz above the incoming frequency. The oscillator is an untuned common emitter crystal controlled oscillator. The capacitor in series with the crystal varies the frequency 2 to 10 kHz being multiplied depending on the type of crystal used, and its activity. An amplifier multiplier section follows the oscillator. The multiplied frequency is injected in the emitter of the mixer. The difference is amplified and detected and then is amplified by the audio amplifier.

The power supply is a voltage doubler, which is regulated by 2 2N706's (cheap kind) as reference voltage and a 2N1038 transistor. This makes a fine regulated power supply.

The majority of the parts may be purchased through your Allied Radio parts catalog except for the coil forms, which were purchased from Newark Radio. The coil forms are Camboin SPC-1 2170-3-3.

I started with the circuit boards. Use the patterns in this article, they are full scale, or try your own design. I used one side foil boards, they are cheap and less complicated in laying out circuits. Your local drug supply should have Ferric Chloride on hand in the solid form or he can get some from his supplier. Dissolve it in hot water and make it strong. I keep dissolving until the solution is almost saturated. Be careful not to spill any; it sure makes a mess. Use only plastic or glass trays for etching. I watched aluminum disappear before my eyes. I used a commercial resistant, but if not available, finger nail polish or model

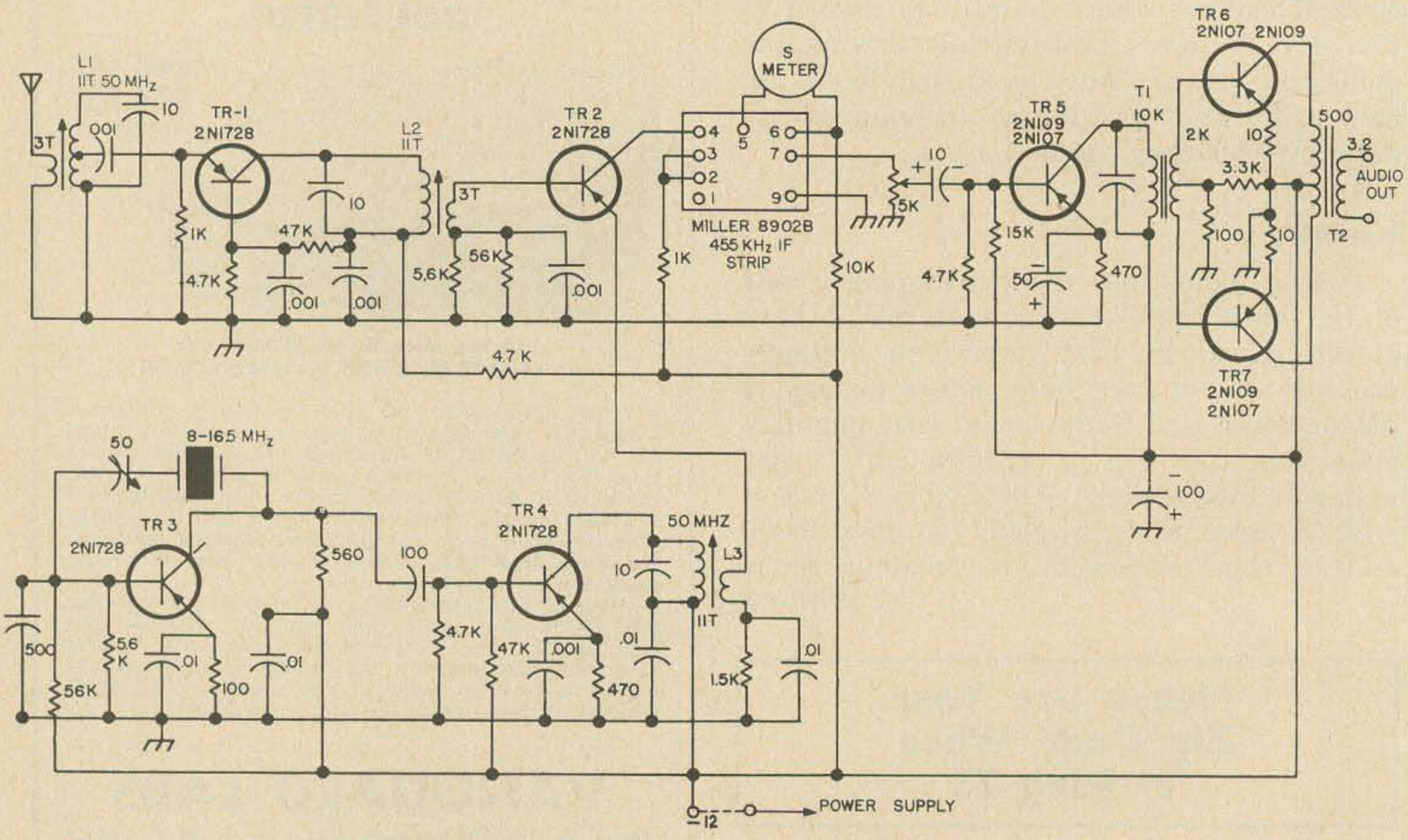


Fig. 1. Schematic for the "Six Net" receiver.

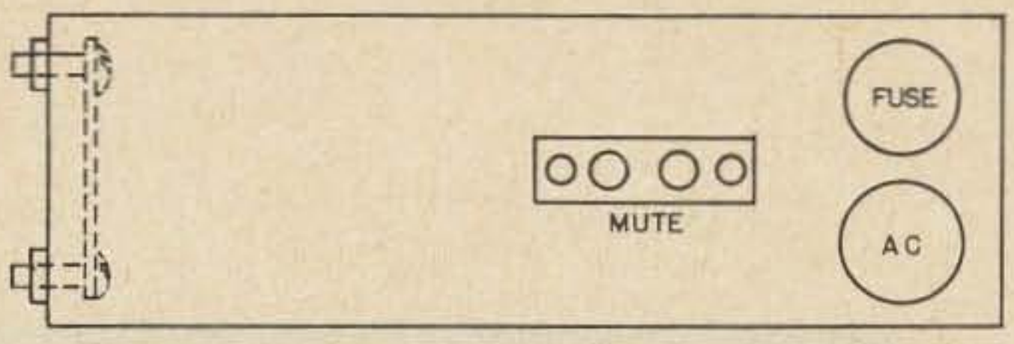
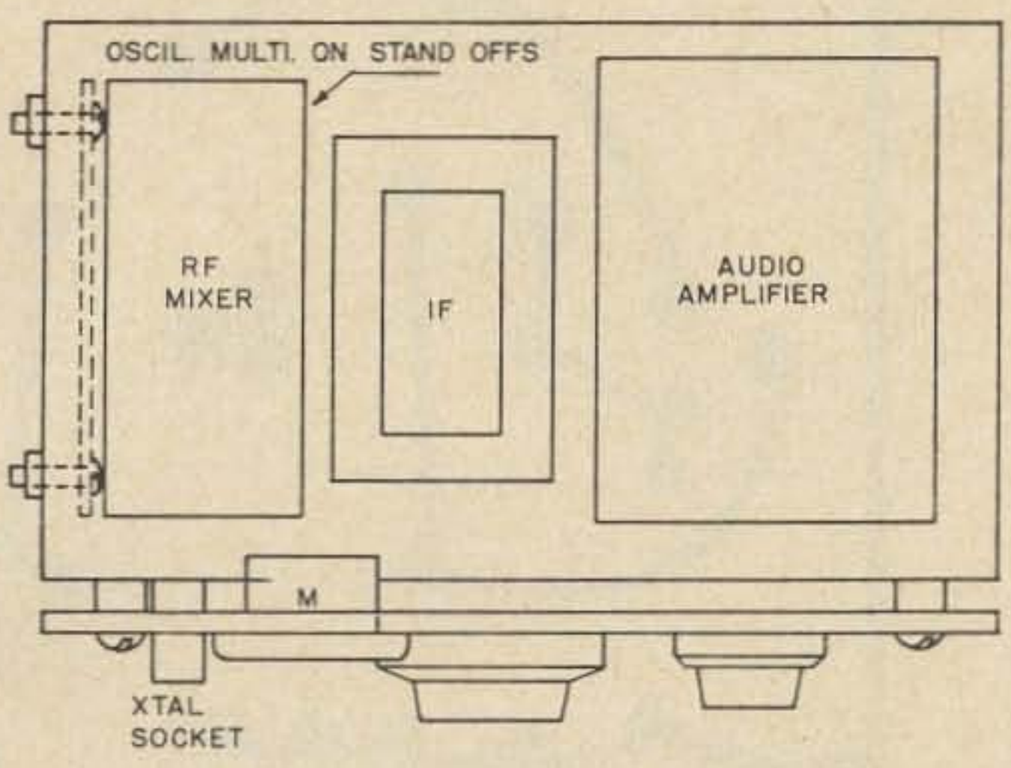
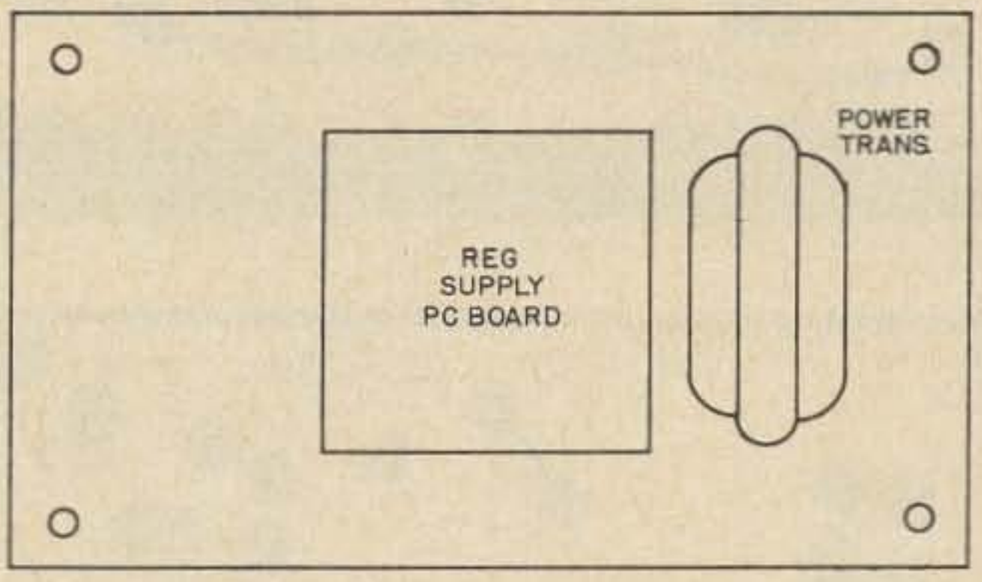
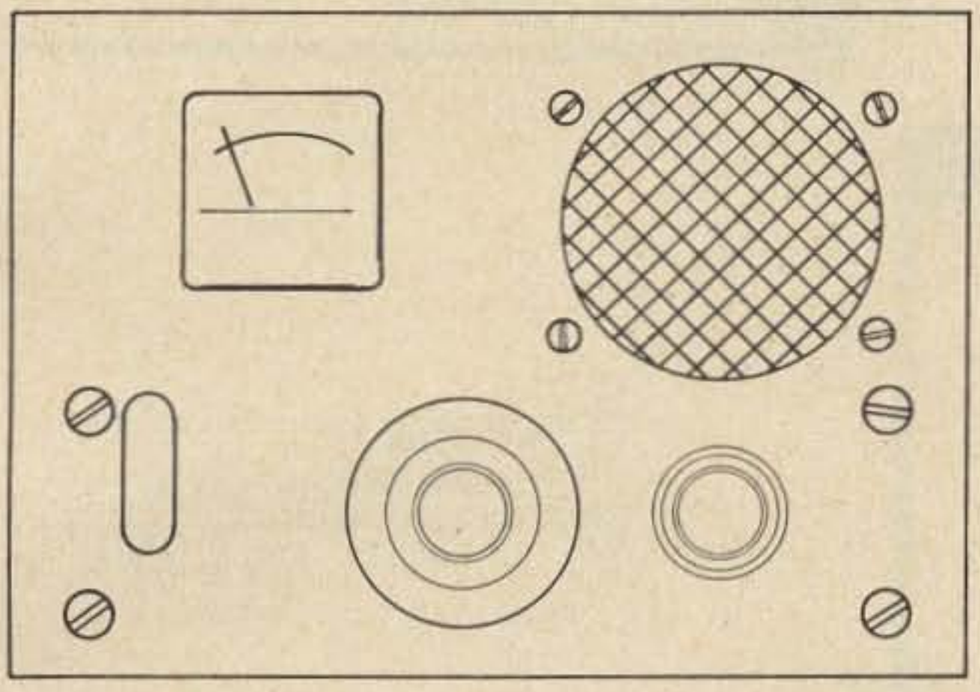


Fig. 2. Layout for the "Six Net" receiver.



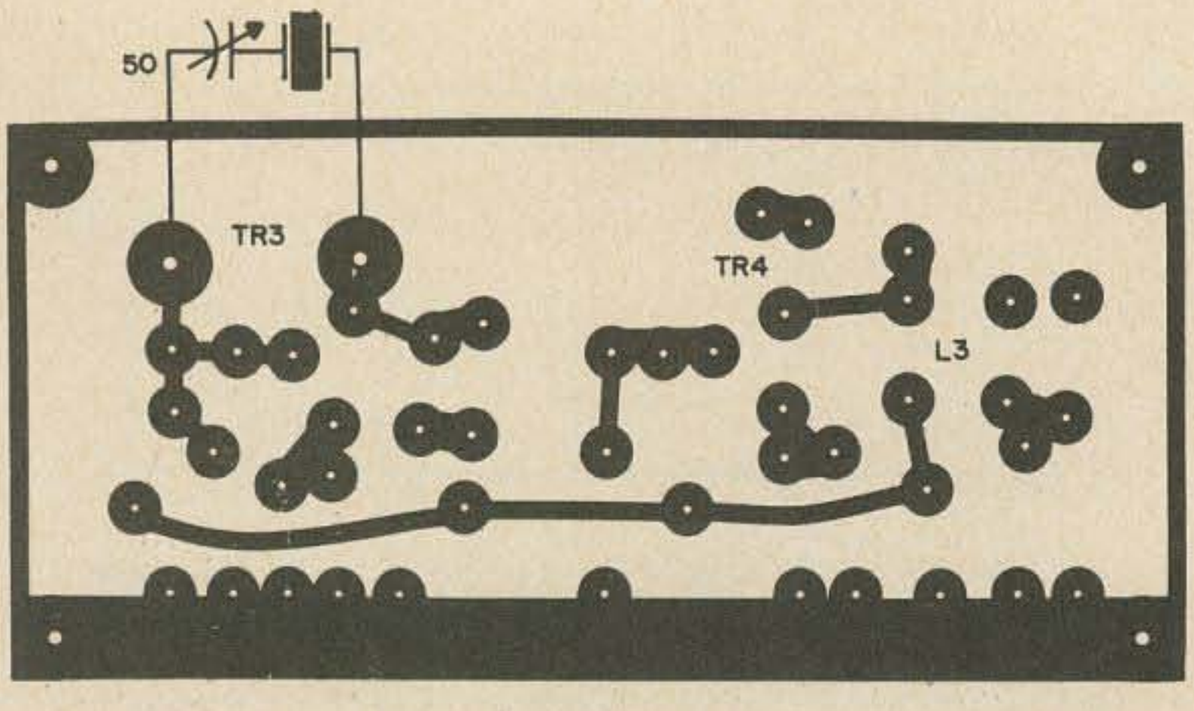


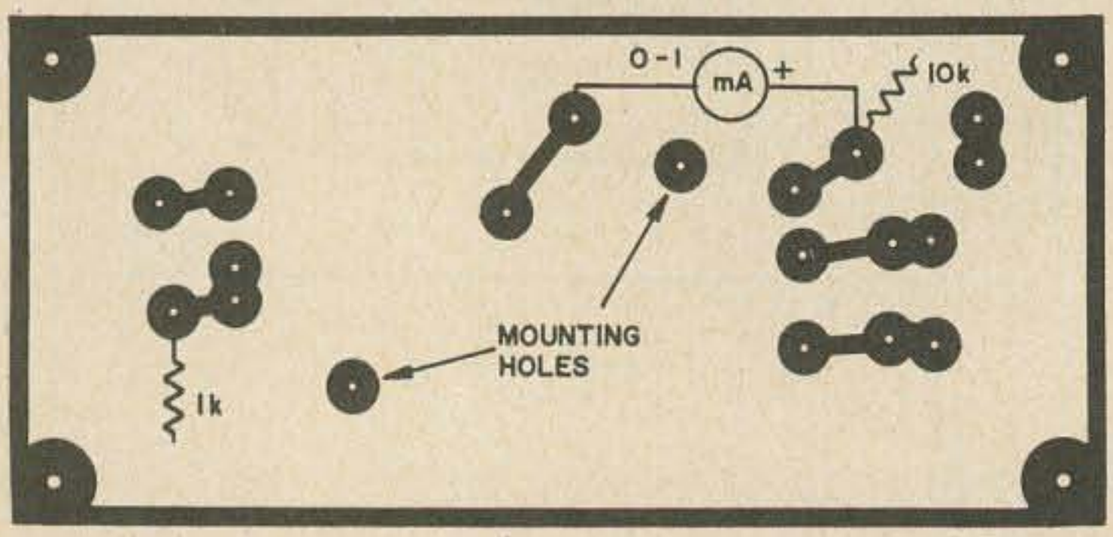


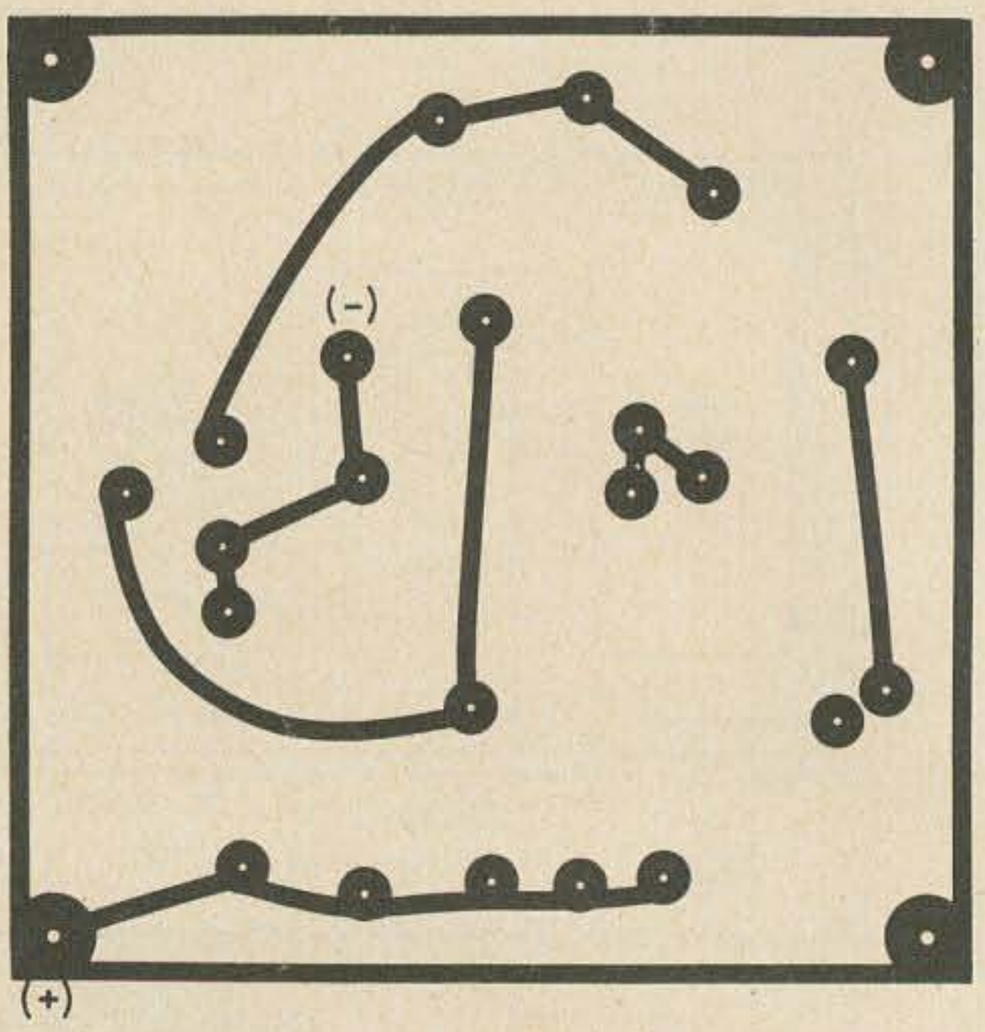
airplane dope will do. It takes approximately 25 to 30 minutes to etch, depending on the strength and temperature of the solution. After the PC boards are completed, drill all holes to take the components and solder them in place. The Miller *if* strip sells for less than $6.00 from Allied Radio. The Miller part number is 8902-B. The transistor driver and output transformer are the standard run-of-the-mill transformers. Almost any of the electronic supply houses have them. The power transformer is an Allied 6.3 @ 0.6A number 54-1416. If anything larger is used it may not fit inside the chassis.

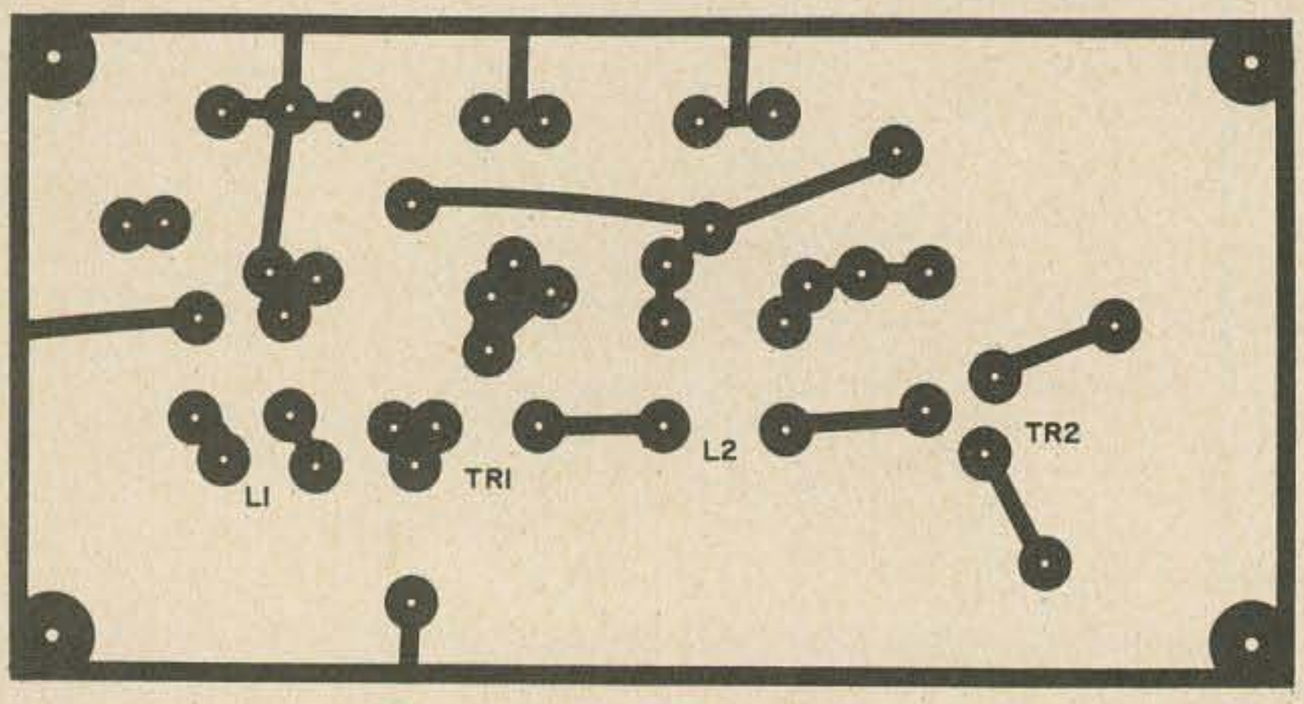
I used a Bud 4 x 6 x 2 inch chassis. The chassis was cut out to take the PC boards as illustrated, except for the oscillator and the regulated power supply. These were mounted on stand offs. The oscillator multiplier is mounted on ½ inch stand offs on the left inside of the chassis below the rf mixer and at right angle to it. The power supply board is mounted on ⅜ inch standoffs on a 4 x 6 x ⅛ inch sheet aluminum which is used for the bottom cover plate. Make cut outs for the meter, speaker, crystal socket, variable frequency control, and the volume control, as illustrated. I used ¼ inch standoffs between the panel and chassis for easier assembly. Cut out the holes on the front and rear of the chassis for the controls on the front, and the ac line, fuse holder, antenna connection and muting terminals on the rear. Assemble the receiver as indicated on the schematic and illustrations.

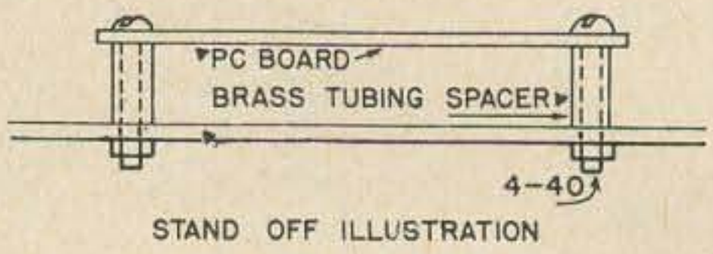
After the wiring has been completed, check it very carefully, making sure no mistakes were made. Dip the rf and mixer coils to approximately 50.4 Plug in an 8325 Hz crystal and turn on the receiver. Ad-











STAND OFF ILLUSTRATION

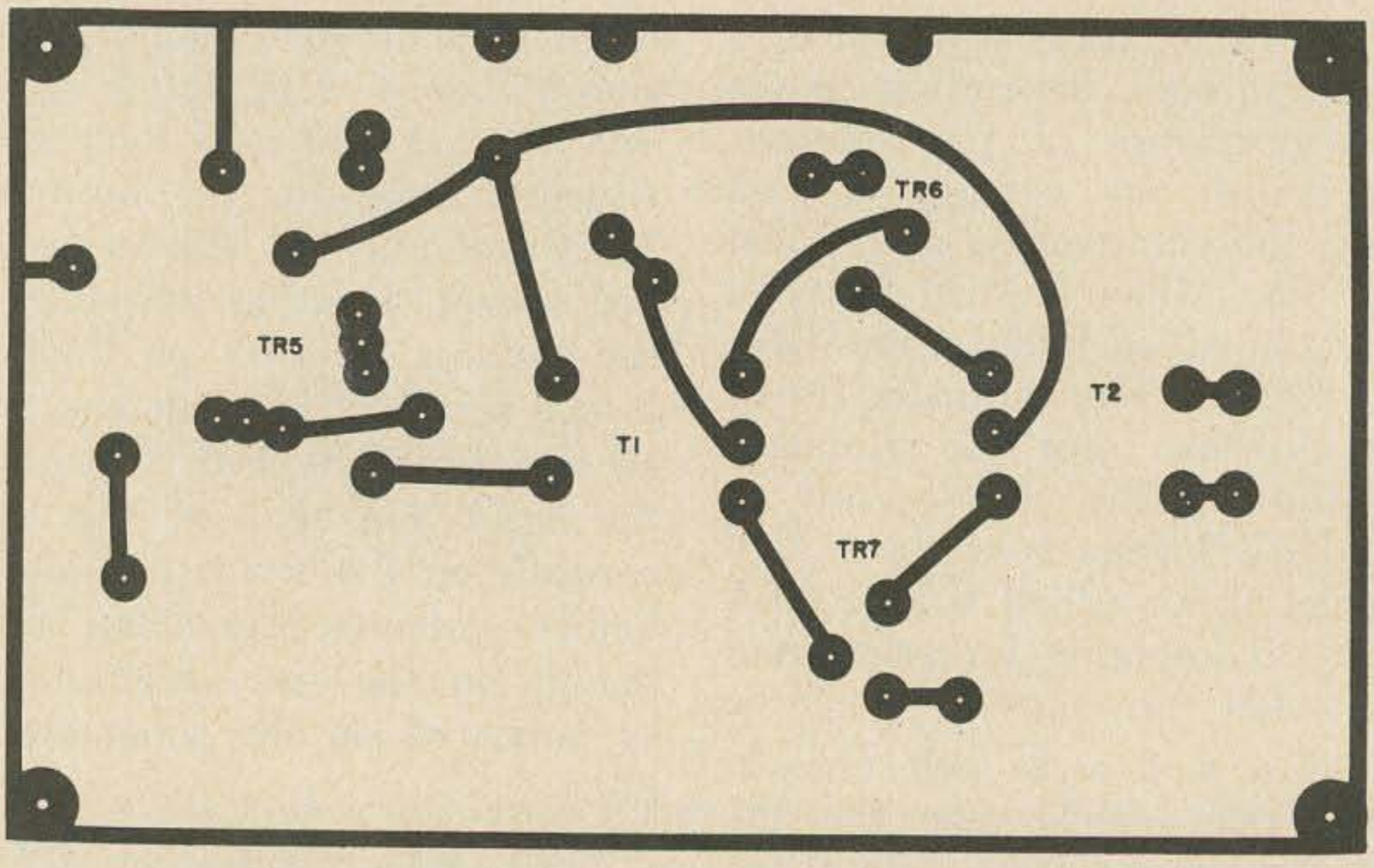


Fig. 3. Printed circuit patterns.

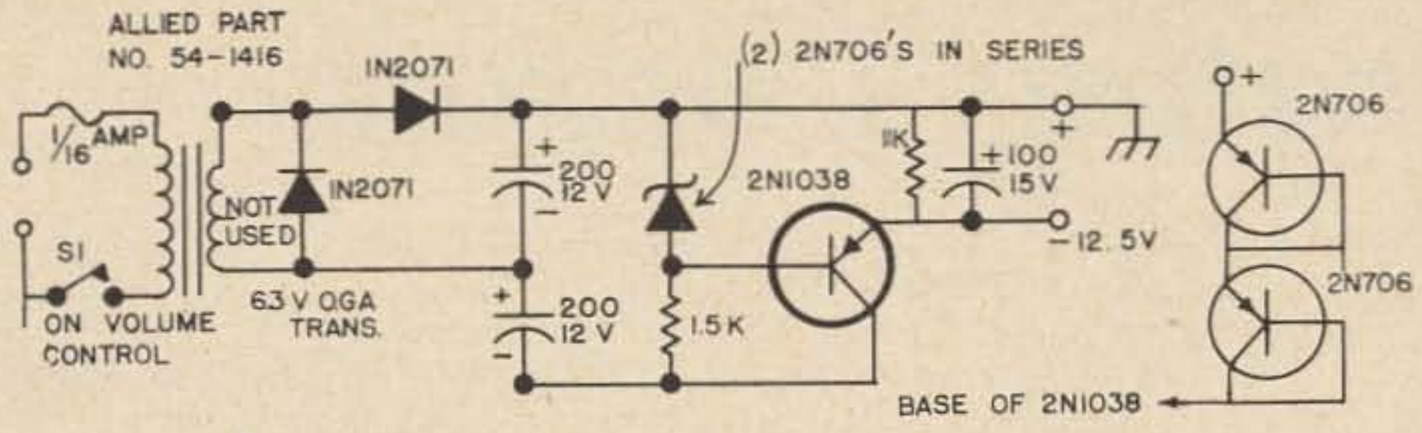


Fig. 4. Diagram for the power supply for the "Six Net" receiver.

just L3 for maximum output with a VTVM. By doing this the receiver will cover frequencies between 49.98 and 50.8 MHz without readjusting L3. Peak L1, L2 and the Miller *if* strip using a signal generator or on the air signal. Here I used the S meter to peak the receiver. The meter will dip, not increase with increase of signal.

The oscillator was checked for stability with a Hewlett Packard counter. The results were no more than plus or minus 20 Hz for any one hour period. I watched the counter for a 15 minute period and observed only 5 Hz change. The tests were made with an 8 MHz xtal.

I have been using the receiver on MARS nets for the past 3 months with excellent results. Here is one receiver which does not require readjusting unless the other stations are off frequency. This will not do for a knob twister.

. . . W5JSN

Pill Box Makes Module

The cylindrical pill box used by most druggists can be made into a module for small electronic circuits. Just take the top off the box and attach an octal plug to the top. The exact method of doing this will depend on whether you use a commercial plug or a salvaged tube base. Now build your circuit so that it fits in the pill box and solder all the power, signal and ground leads to the octal plug with all connections corresponding to the mating socket. For permanence, a bit of epoxy glue will keep the top of the box and the box proper together. A natural use for this type of module is a solid state rectifier replacement for tube rigs.

Pill boxes can also be used to cover relays and keep dust from causing erratic operation.

If you are luckier than most people and don't take pills, you can buy these pill boxes from a druggist for about a nickel apiece.

D. E. Hausman VE3BUE

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196-23 Jamaica Ave., Hollis, NY 11423

An Operating Console

P. Kimball W6GDP
583 Market St.
San Francisco, Calif.

Suggestions for Dressing up the Station and Improving Operating Convenience

Most of us started in amateur radio with rather simple equipment in the shack, i.e., transmitter, receiver, mike and key. We all have a tendency to improve and upgrade the station by adding outboard accessories. If you are a typical amateur, the chances are that, after a short time, your operating position will begin to resemble a storage area for black boxes, meters, dials and wires. These outboard accessories usually include: clock, SWR bridge, voltmeter, phone patch, field strength meter, antenna switch, telephone, ten minute timer, etc., et al.

As a first step in improving the appearance of the station, as well as operating convenience, the author decided to mount all the outboard equipment at his station in one console. The photo shows this console which includes all of the above mentioned accessories with room left for future expansion.

The console front was made from ⅛" aluminum panel and the case from ¾" plywood on a 1" frame, well reinforced. The accessories, which were already mounted in boxes or cabinets, such as the SWR bridge, were installed in the panel after first making a cardboard template of the parts which would project through the panel, to aid in their cutout; then the boxes were mounted against the panel by metal straps.

All panel cutouts were made with ¼" electric drill and sabre saw using a metal cutting blade. A valuable aid in working wih aluminum, using electric hand tools, is an SCR speed reducer to limit the speed to fit the condition; several such kits are on the market.

The console overall dimensions should be adequate to house the equipment to be installed and should be sufficiently sturdy to support the transmitter, receiver or other equipment which may set on top. It can easily be built into a desk at an angle if a sloping face panel is desired. The overall dimensions of the author's are 51" long, 8" high and 15" deep.

It was decided to monitor both ac voltage and current using switchboard type meters which are usually available surplus at very reasonable cost. The ammeter reads direct from 0 to 5 amps. An additional scale from 0 to 25 amps (to be used when a linear is in operation) was incorporated by switching in a surplus 200 to 5 amps ratio current transformer in the primary. Eight turns of the primary 120 volt wire through the transformer window will produce 5 amps in the transformer secondary with 25 amps flowing in the primary. Other ratios are usually obtained by varying the number of turns. **Fig. 1** shows the complete 120 volt ac power wiring which should be at least #10 in size but in no case smaller than that required to carry the current and meet

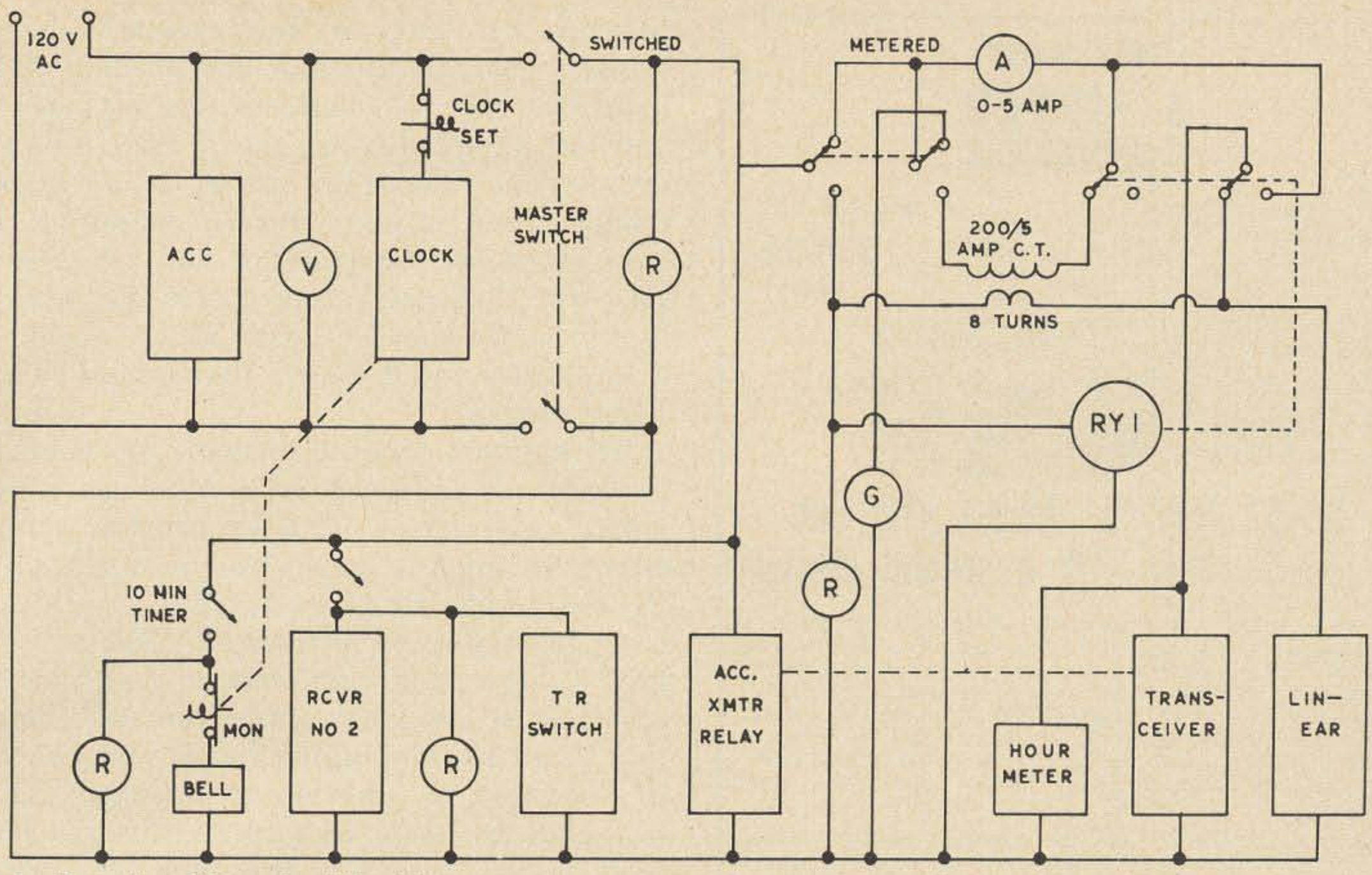

Fig. 1. Complete 120 volt AC wiring.

all applicable codes. The back of the console contains recepticles for the ac lines from the transmitter, receiver, linear etc. It also holds the inputs for mike, telephone and tape recorder as well as an additional relay for muting outboard receivers, lighting "on the air" sign, etc. This relay is operated by an auxiliary contact on the antenna relay on the transceiver. The totalizing hour meter is 110 volt ac surplus and indicates total heater hours on the transmitter. Additional meters may be used to show plate hours, linear heater hours, etc.

Fig. 2 is a block diagram for the *rf* circuit and audio circuits. The coax switch allows any of three antennas or a dummy load to be selected. The audio input selector switch is a three pole, six position rotary type which should be shielded.

The console also includes a mike preamplifier and speech compressor. The telephone dial was mounted on the front panel and the hand set on the side for convenient use. In addition, a hybrid phone patch is installed which can be cut in and out at will. With the patch cut in, the receiver

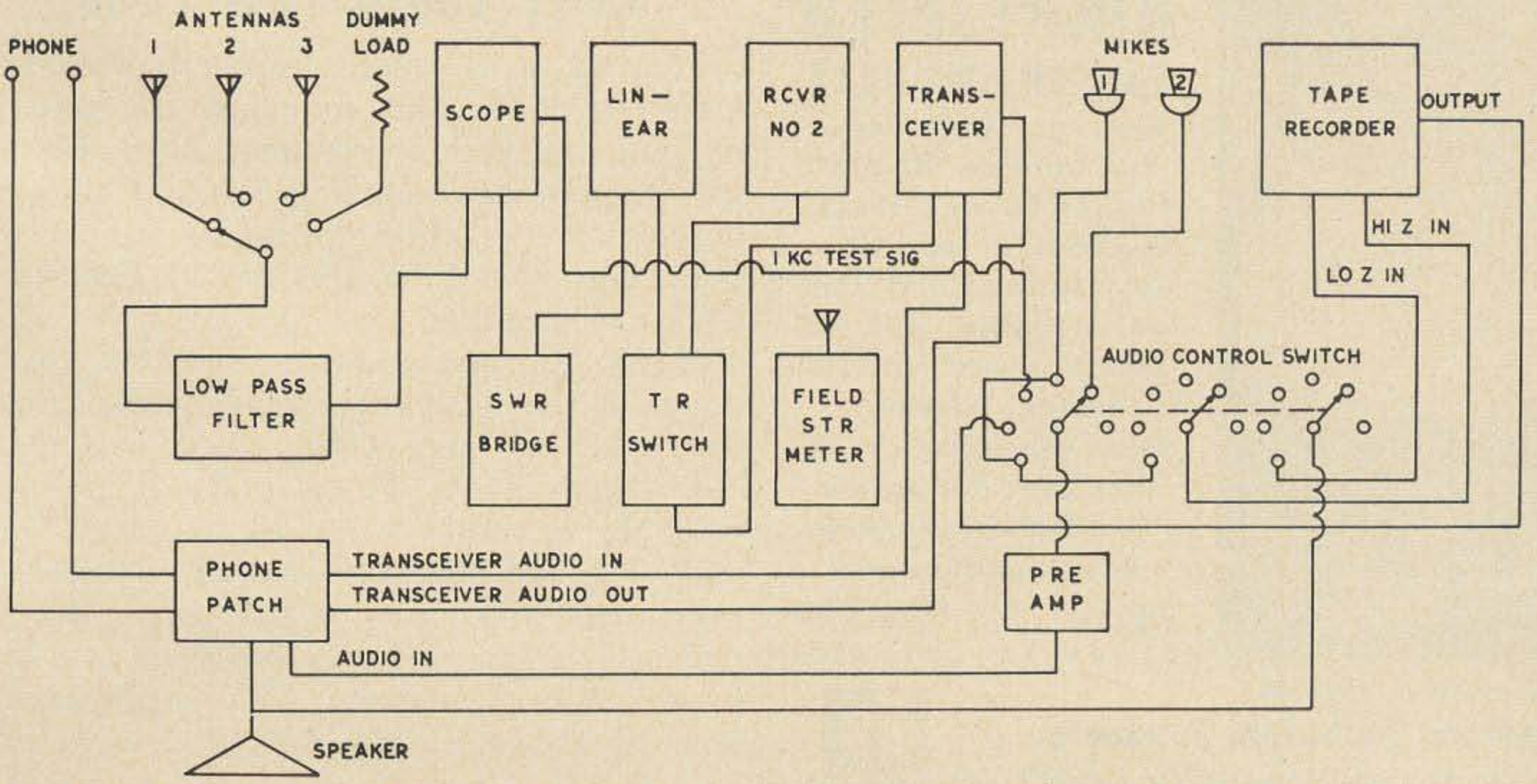

Fig. 2. Block diagram for rf & audio circuits.

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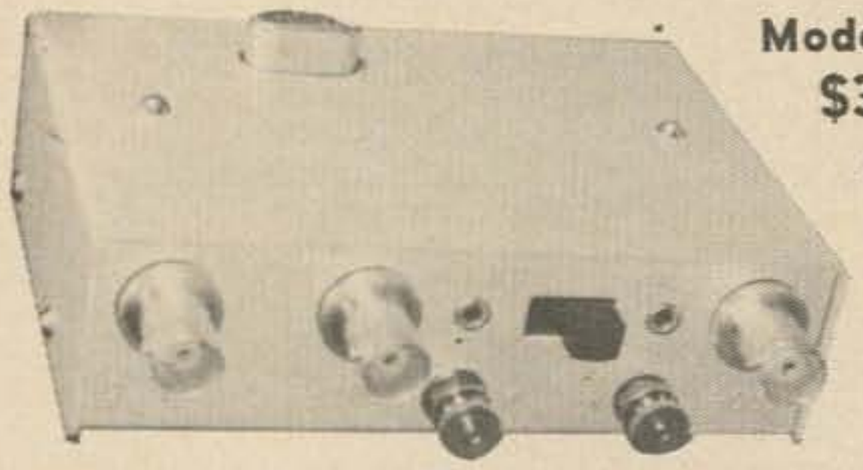

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speaker is muted, and monitoring is accomplished through the receiver portion of the hand set. The ac switches are rocker type and the pilot lights are inexpensive 110 volt neons. The aluminum panel is easily obtained from surplus. Before mounting the equipment on the panel it can be given a pleasing "brushed" appearance by sanding lightly and spraying with clear acrylic or if desired, painted with a high grade switchboard enamel.

All stations tend to become personalized because of different equipment and individual preferences. This article was written merely to suggest some ideas on approaching the design of a functional console, and details have been purposely omitted. The two factors of operating convenience and pleasing appearance are most important and the author's console has added much real pleasure to operating in addition to bringing admiring glances from visitors to the shack. A construction project of this type is relatively simple and offers much satisfaction for those of us who have a yen to build a part of the equipment in the shack, yet do not feel technically competent to tackle modern transmitter or receiver design and construction.

. . . W6GDP

Rack Those Test Leads

Is your workbench always cluttered up with test leads that somehow seem to get tangled up with everything else? Do you spend more time looking for and then untangling a special test probe or jumper wire than you spend in the actual process of testing or jumping?

If you do, you no longer have to. Just go down to the local drug store or department store and ask one of the employees for an old display rack. These racks hold everything from combs to small packaged items and when all the products on the rack are sold, usually the rack is discarded. But you can use such a rack to store your test leads in a 'civilized' manner. The appearance of your workbench will be 100% neater!

D. E. Hausman VE3BUE

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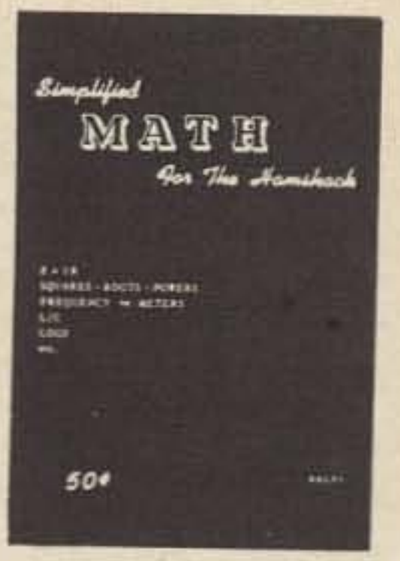

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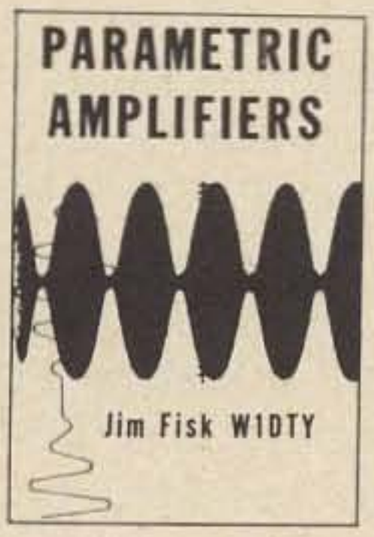

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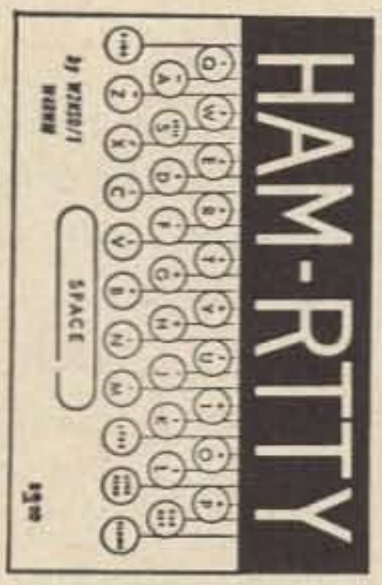

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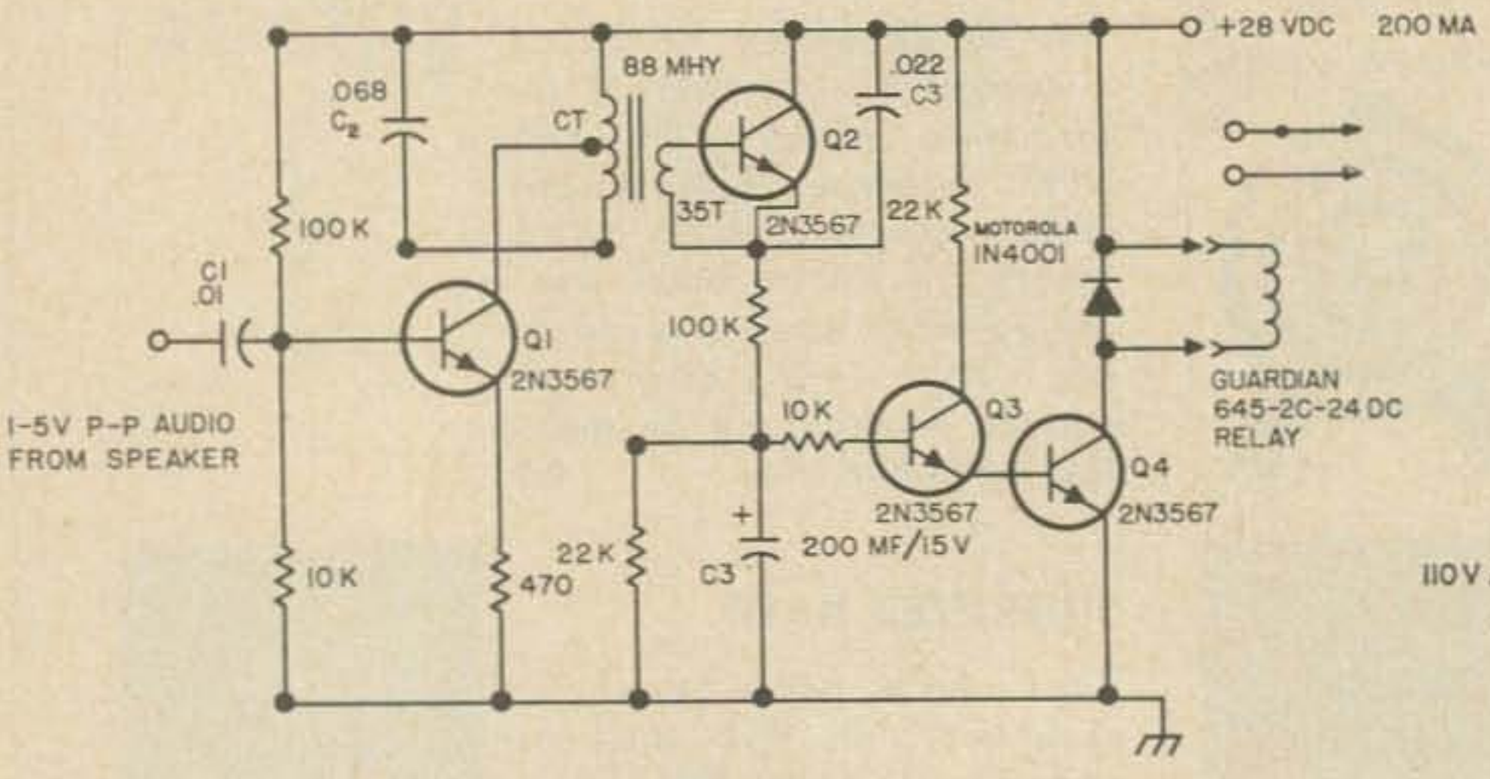
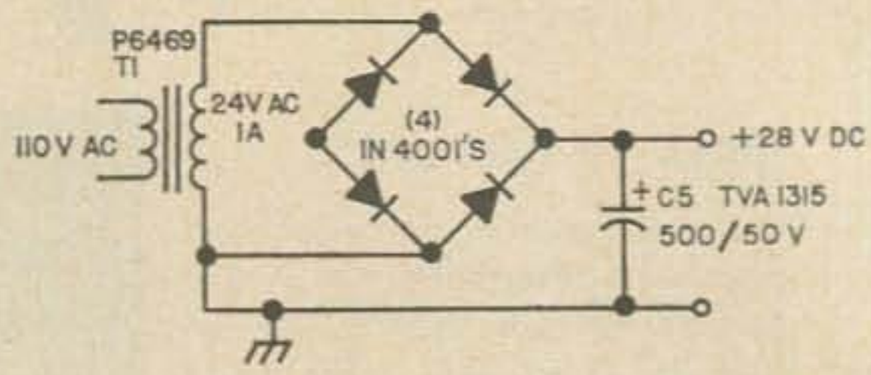
RTTY Autostart

Thomas R. O'Hara W6ORG
10253 *E. Nadine*
Temple City Ca 91780





This autostart circuit is versatile in that it connects to the speaker instead of digging into the TU, is solid state and therefore small, and can be hooked up to turn on the teletype machine and TU power. The power supply requirement is +24 to 28 VDC at 10 mA no signal to 200 mA with signal. This autostart was designed originally for monitoring USAF MARS VHF nets where both voice and teletype are used. Many stations operate on VHF and HF SSB simultaneously. With this device it is not necessary to stop copying on HF to turn on the teletype machine. It insures that you receive all RTTY copy on the net.

The first transistor is a tuned amplifier. The input audio must be in the range of 1 to 5 volts peak to peak which is the normal listening range voltage for a 4 to 8 ohm speaker. For a 600 ohm impedance a resitive devider consisting of a 1 k and 10 k resistor or a 600 to 8 ohm transformer must be added. The tuned circuit is resonant to the standard mark frequency of 2125 Hz. Any combination of L and C may be used for other tone frequencies for selective call, etc. The coil is the usual 88 mH toroid available on surplus. Bandwidth is approximately 150 Hz. The .068 capacitor should be a good mylar type for frequency stability. Turns may have to be taken off to get exact resonance for best performance. If the .068 capacitor is close to tolerance, about 35 turns should be taken off. The link couples about one volt at resonance to the switch transistor Q2 which then turns on and allows the 100 mfd capacitors to charge up. When this charging voltage gets up to 1½ volts the relay drivers Q3 and 4 turn on and energize the relay. The 100 k resistor with a 100 ohm relay gives about 3 seconds before turn on. Likewise it takes about 3 seconds to drop out in absence of a steady mark tone. The time out is determined by the relay coil resistance and the 22 k resistor. Both the 100 k and 22 k resistors can be varied for any desired time in and out up to 10 seconds.

Operation

Hook up the input to an audio source of 2125 Hz and take off 5 turns at a time from the hot side of the toroid until maximum voltage is shown on a scope or ac VTVM. Check the time in and out of the relay and change the 100 k and 22 k resistors for the desired length of time. The relay should have 10 amp contacts because of the starting current of the teletype machine.

Construction can be on a chassis, vector or PC board as the circuit is not critical to pickup or capacitive effects as with other types of autostarts. I can supply a PC board for $2.50 or a completed tested unit for $15.00 post paid.

This circuit is great for both the lazy man and the busy man and ensures that you get all the teletype copy on the net.

. . . W6ORG

Unique opportunity to own one of the world's finest all-band receivers. 500 kc to 32 mc!

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Oscillator Frequency-Shift Calculations

Jack McKay WA6DPD/3
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It is always of interest, when designing an oscillator, to know how much frequency shift will result from a change in component values, whether intentional or unintentional. A few equations for such calculations are given here.

I. An approximate equation for relative frequency change $\frac{\Delta f}{f}$ caused by a relative capacity change $\frac{\Delta C}{C}$ or a relative inductance change $\frac{\Delta L}{L}$:

$$\frac{\Delta f}{f} = \tfrac{1}{2}\,\frac{\Delta C}{C} = \tfrac{1}{2}\,\frac{\Delta L}{L}$$

Suppose, for example, that a tuned circuit with C = 100 pF, L = 1.27 uh, f = 14.0 MHz uses a fixed capacitor with a negative temperature coefficient of 750 parts per million per degree Centigrade, and the ambient temperature rises 5° C. The change in capacity is $750 \times 10^{-6} \times 5 \times 100 = 0.375$ pF. The relative change in capacity is $\frac{0.375}{100}$ = 0.00375. The frequency will increase by approximately

$$\Delta f = \tfrac{1}{2}\, f\frac{\Delta C}{C} = \tfrac{1}{2} \times 14.0 \times 0.00375$$

$$= 0.02625 \text{ MHz} = 26.25 \text{ kHz}$$

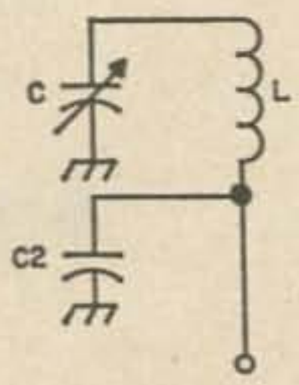

Fig. 1. A bypass capacitor in a tuned circuit.

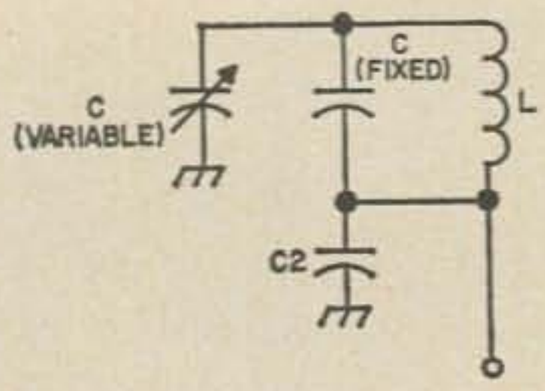

Fig. 2. A fixed capacitor wired on the inductor side of the circuit.

The new resonant frequency will be about 14.026 MHz. Working out an exact answer is long and laborious, and cannot be slide-ruled because of the great accuracy needed for calculating an increase in frequency of less than 0.2%. A more precise result for the new resonant frequency is 14.02633 MHz, virtually identical to the result obtained using the simpler equation.

Conversely, if a zero-temperature-coefficient capacitor is used in the above tuned circuit, and the frequency is observed to drift down 26 kHz when the temperature increases 5° C., substitution of an N750 capacitor will reduce the drift to near zero.

This equation can also be used for rough calculations of the capacitors necessary to tune a given frequency range. Suppose it is desired to tune 7.00-7.30 MHz and a 6-80 pF variable is available. How much fixed capacity is necessary in parallel with the variable to tune the range?

The relative frequency change is $\frac{\Delta f}{f} = \frac{0.300}{7.150} = 0.042$. The relative capacitance change must be twice this, or 0.084. The capacitance change available is 74 pF, so the total capacity at center frequency must be $\frac{74}{0.084} = 882$ pF. Center capacity of the variable is 43 pF, so 882 − 43 = 839 pF is required in parallel with the variable to tune this range.

II. An exact equation for the frequency range tuned by a variable capacitor with capacity range ΔC, or by a variable inductor with inductance range ΔL, is

$$\left(\frac{f_1}{f_2}\right)^2 - 1 = \left(\frac{f_1}{f_2} + 1\right)\left(\frac{f_1}{f_2} - 1\right)$$

$$= \frac{\Delta C}{C_1} = \frac{\Delta L}{L_1}$$

where f_1 = resonant frequency for $C = C_1$ or $L = L_1$ (the higher resonant frequency)

f_2 = resonant frequency for $C = C_1 + \Delta C$ (variable capacity) or $L = L_1 + \Delta L$ (variable inductance)

Taking the example above, with the 6-80 pF variable capacitor for the frequency range 7.00-7.30 MHz, and calculating C_1:

$$\frac{f_1}{f_2} = \frac{7.30}{7.00} = 1.4029$$

$$C_1 = \frac{C}{\left(\frac{f_1}{f_2} + 1\right)\left(\frac{f_1}{f_2} - 1\right)}$$

$$= \frac{74}{(2.0429)\ (0.0429)} = 844 \text{ pF}$$

This is the minimum capacity, for resonating at the higher frequency; allowing for the 6 pF minimum capacity of the variable, 838 pF (less stray capacitances) is required in parallel with the variable.

The close agreement between the calculation with the approximate equation and the exact equation is due in this case to blind luck. For $\frac{\Delta f}{f}$ above a few percent, when accurate results are needed, the exact equation must be used; for very small $\frac{\Delta f}{f}$ or where only approximate results are needed, the simpler equation can be used.

III. Frequently a bypass capacitor is used in a tuned circuit, as in **Fig. 1.** The bypass and the tuning capacitor are effectively in series. How much frequency drift is caused by a variation in the capacity of the bypass? An approximate equation for the net change in capacity of the two capacitors in series is

$$\frac{\Delta C}{C} = \frac{C}{C_2}\left(\frac{\Delta C_2}{C_2}\right)$$

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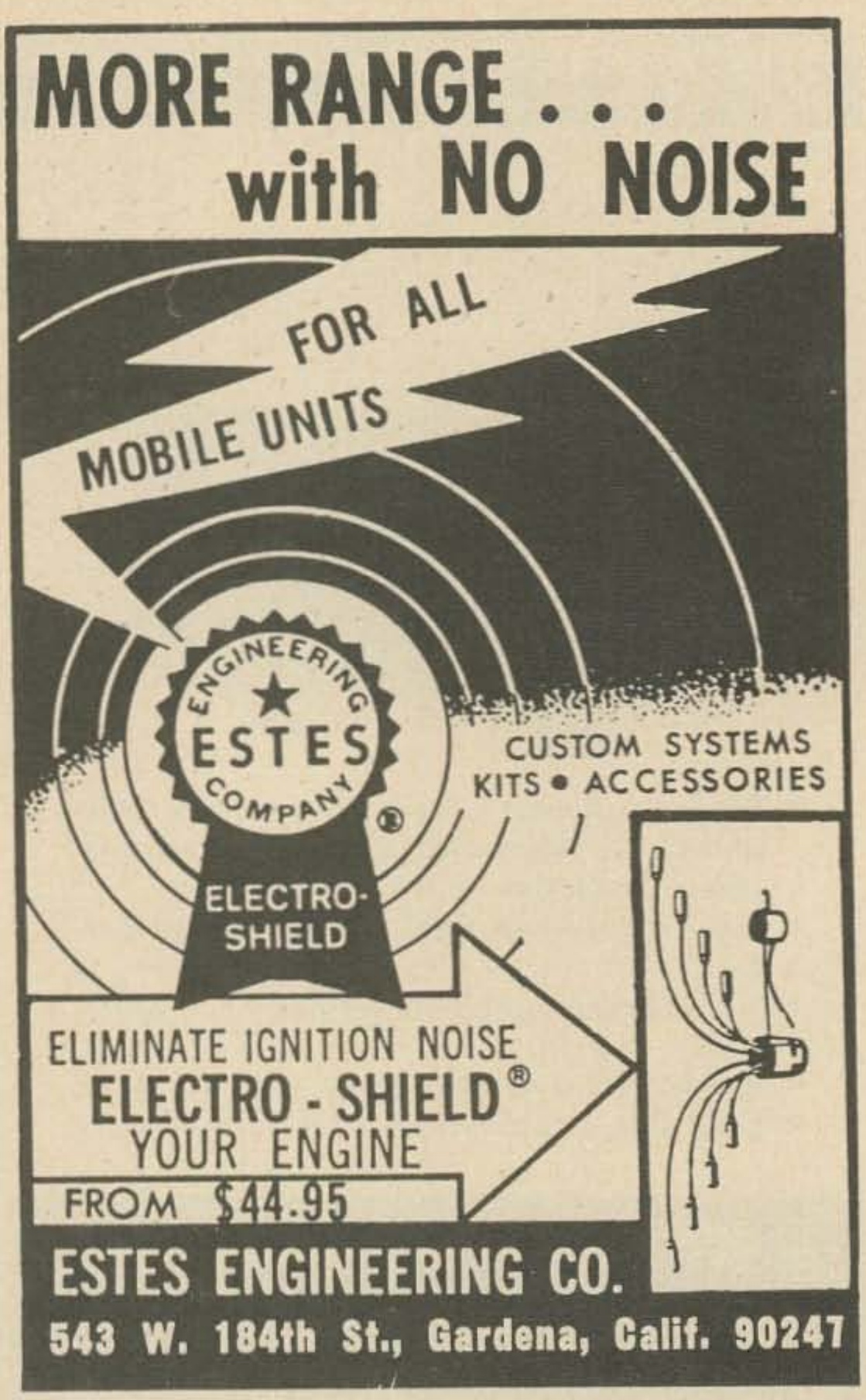

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where C = capacity of tuning capacitor (about the same as the net capacity of the capacitors in series)
C_2 = capacity of the bypass capacitor
ΔC_2 = change in C_2.

Suppose that C = 844 pF, f = 7.30 MHz, and C_2 = 0.02 μF with temperature coefficient 1% per degree Centigrade (typical for general-purpose ceramics). For a temperature rise of 5° C., the change in C_2 is 5%; $\frac{C_2}{C_2} = 0.05$. Then

$$\frac{\Delta C}{C} = \frac{844}{20{,}000} \times 0.05 = 0.00211$$

The first equation of this article can be used to calculate the frequency drift:

$$\Delta f = \tfrac{1}{2} f \frac{\Delta C}{C} = \tfrac{1}{2} \times 7.30 \times 30 \times 0.00211$$

$$= 0.00766 \text{ MHz} = 7.66 \text{ kHz}$$

Since C_2 is increasing, the resonant frequency decreases by 7.66 kHz. Thus the tuned circuit components could be perfect, and the drift would still be excessive for a VFO, because of variation in the bypass capacitor.

This drift can be sharply reduced in this case very easily. The tuning capacitance C is made up of a variable in parallel with an 838 pF fixed capacitor. Suppose the fixed capacitor is wired on the inductor side of the circuit, as in **Fig. 2.** Then the bypass is in series with only the 6-80 pF variable capacitor. At the high-frequency end the variable capacitor contributes only 6 pF and the variation in bypass capacity will be entirely negligible. At the low-frequency end (f = 7.00 MHz) the variable is set at 80 pF, and the effective change in capacity for a 5-degree heating as before is

$$\frac{\Delta C}{C} = \frac{80}{20{,}000} \times 0.05 = 0.0002$$

or $\Delta C = 0.0002 \times 80 = 0.016$ pF.

Then, using the first equation for $\frac{\Delta f}{f}$,

$$\Delta f = \tfrac{1}{2} f \frac{\Delta C}{C} = \tfrac{1}{2} \times 7.00 \times \frac{0.016}{(838 + 80)}$$

$$= 6.1 \times 10^{-5} \text{ MHz} = 61 \text{ Hz}$$

The drift is less than a hundredth of what it was with the fixed capacitor on the tuning-capacitor side of the bypass.

Note also that increasing the bypass capacitance with temperature coefficient unchanged decreases the frequency drift. Therefore bypass capacitors for high-stability oscillators should be as large as internal resonances permit.

. . . WA6DPD

Accurate if Alignment

I hear many hams talk of the trouble they have in accurately aligning the *if's* of their receivers, especially some of the newcomers using a converted surplus receiver. I have been using the procedure listed in **Fig. 1** for years, and find that most receivers will come close to reading correctly if the *if's* are set correctly before any *rf* or oscillator alignment.

As all American BC stations use 10 kHz separation and are crystal controlled, I use them to check signal generator settings. For instance, suppose I want to align a receiver with an *if* frequency of 1680 kHz. Setting the signal generator at 420 kHz, its 2nd harmonic should zero beat with a broadcast carrier at 840 kHz. Then its fourth harmonic is within a few cycles of 1680 kHz, and is used for the *if* alignment. To align a 455 kHz *if* accurately, I zero beat the signal generator's second harmonic of 455 kHz against a 910 kHz broadcast carrier, and align from the fundamental.

This approach is very accurate, and the signal generator needs a 30 minute warmup before doing alignment work. If the receiver *if* is known to be far off, I do a rough alignment before using the above procedure.

if Freq. of rcvr.	Sig. gen. setting	BC station zero beat at:	Harmonic beat with BC sta.	Harmonic for alignment
260 kHz	260 kHz	780 kHz	3rd	Fund.
262 "	262 "	1310 "	5th	"
266 "	266 "	1330 "	5th	"
455 "	455 "	910 "	2nd	"
915 "	305 "	610 "	2nd	3rd
1650 "	330 "	660 "	2nd	5th
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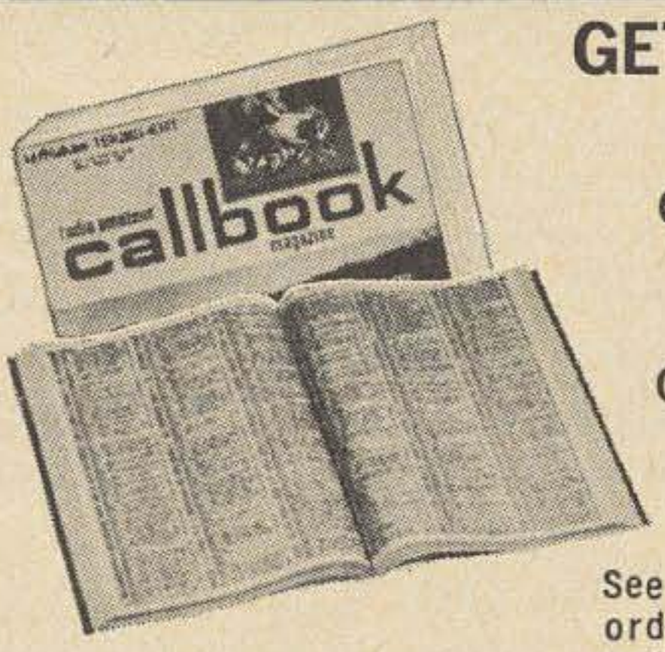

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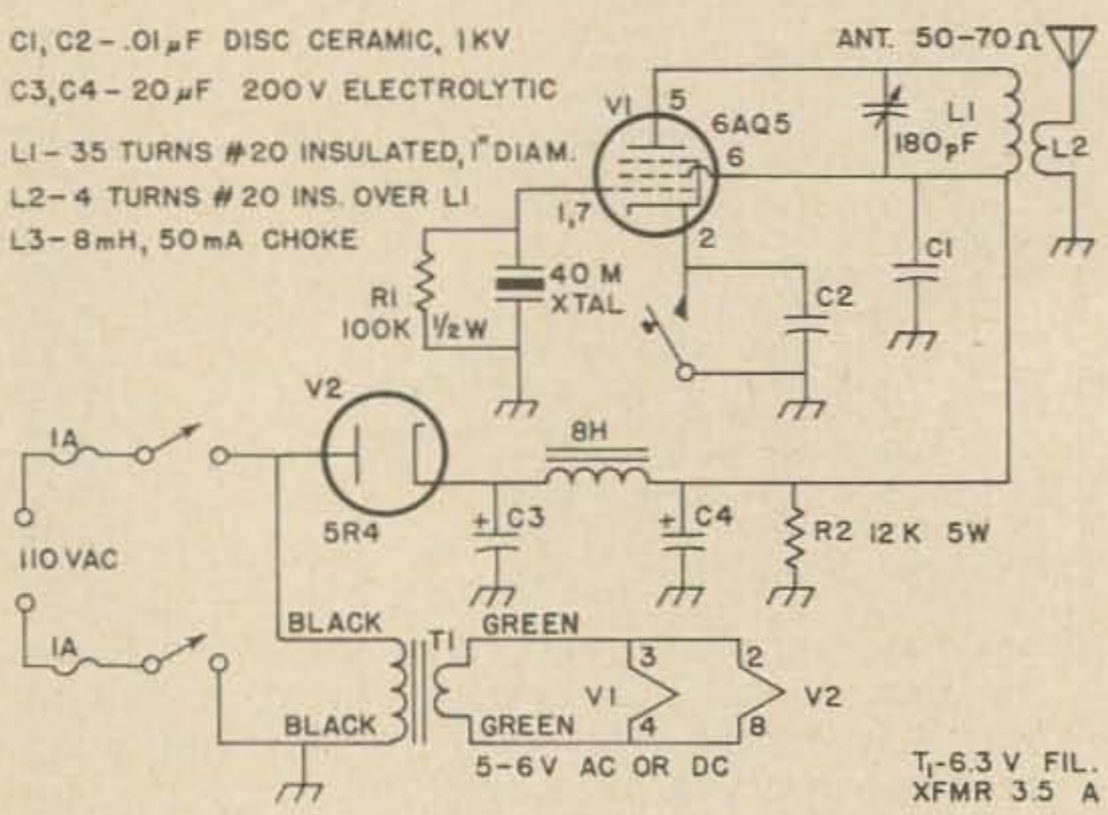

The rig described here should fill the bill for a standby when the big rig breaks down, or to persue QRP hamming. The transmitter can run about 15 watts on 40 into a 50-70 ohm load. If power is borrowed from another source, all the rig consists of is a tube, a resistor, two capacitors, and a coil. You should be able to build it breadboard style in the time it takes the station receiver to warm up!

The circuit is a simple crystal oscillator making use of the pentode tube. The circuit is tuned by the plate to cathode capacity within the 6AQ5. The final is dipped by permeability tuning of the coil. A similar triode circuit was popular during the '30s using 6L6's, which you old timers may remember.

Start scrounging the parts from old TV's which can be obtained for the asking from service shops. The old sets contain plenty of goodies; a husky power transformer, capacitors, resistors, chokes, a speaker, and some FB tubes.

Almost all of the parts can be found inside a TV set of late vintage. You may have a bit of trouble locating the 6AQ5, but be persistant and you will find one, usually after looking through about half a dozen sets. Because of the low level of *rf*, the socket can be the original ripped out of the set, and not a special porcelain one. While C_1 and C_2 are specified as .01 μF they can be almost any value that your TV set uses for bypassing. Anywhere from .005 μF to .02 μF is fine here. L_1 is wound on a one inch diameter cardboard form and consists of about 35 turns of #20 wire. This amount of inductance is not enough to resonate the circuit at 40 meters, but more inductance is added later by inserting a ferrite rod into the coil. A two inch piece of a loopstick from an old BC radio is ok for this. Wind L_2 directly over L_1, about 25 turns from the hot end. Be sure to wind it in the same direction or you will get a phase shift in the output signal. Twist the ends of L_2 after winding to keep it from unwinding. A tube socket from the television or a similar receptical can be used for the crystal socket. A special crystal socket doesn't seem to be necessary.

The easiest way to supply power to the rig would be to borrow it from another source. A BC radio, record player, or tape recorder will usually provide about 150 volts of B plus. That's enough to run about two watts input. The power supply I used is of the ac-dc type. The TV should contain a suitable five volt rectifier, choke, and electrolytic capacitors. Check the caps with a VOM to be sure they are not shorted before using them. The choke, L_3 is not critical and can be anything that resembls a choke. You can even use the primary of the TV's speaker output transformer. Bleeder resistor R_1 is also not critical but should be about 100 ohms per volt that the power supply will handle. Be sure that R_2 is conservatively rated, because a blown bleeder resistor is more dangerous than none at all. Also, if you use an ac-dc power supply don't try to connect it to an earth ground or use a VFO with a grounded shield on its output. If you do, stock upon plenty of fuses for your house.

To put the transmitter on the air, hook one side of L_2 to a 50-70 ohm antenna. Plug it in and give it the smoke test. If

everything is ok, insert the ferrite rod into the coil and tune for a dip on a 0-50 mA meter connected at point "X". Tape a cardboard arm about four inches long to the ferrite rod so the final can be dipped without being detuned by your hand. The current at resonance will be between 10 and 40 mA, depending on the B plus voltage.

Running about one watt input on 40 meters to a dipole here in two-land, I can work four and nines nightly, and occasionally a zero. I have really been surprised at the performance of my li'l rig, as I know you will be.

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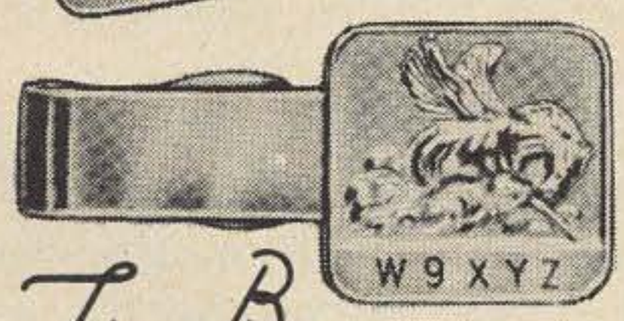

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Sams has announced several new and reprint books for electronics workers.

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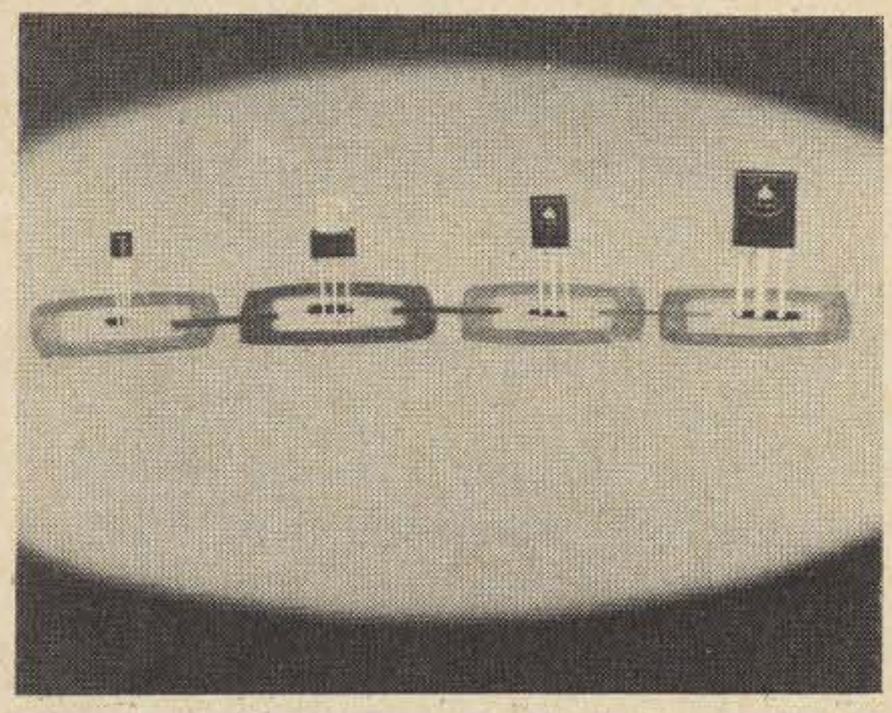
The North American Radio-TV Station Guide, by Vane A. Jones, ($2.95) appears in a new 5th edition. Listings include frequencies, call letters, locations, and network affiliations, and other data for AM, FM, and TV stations in the U.S., Canada, Cuba, Mexico, and the West Indies. Over 9500 assorted stations are listed. Sams #20635.

Write to R. R. Fleck, Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, Indiana 46268 for further information. Try your distributors' too, since the books may already be there.



Motorola Uniwatt Transistors

Here are some new transistors to fill in the gap between little transistors and big transistors. Medium-size transistors.

Motorola's new Uniwatt transistors can dissipate up to 1 watt in air, or eight watts into a well-designed heat sink. All are silicon annular transistors, offering good high-frequency response. They are encased in plastic packages, with a copper tab for heat-sinking. See second from left in the photo.

Prices are quite low, and get up over a dollar for some of the Uniwatt transistors. For more information write to the Technical Information Center, Motorola Semiconductor Products, Inc., Box 20924, Phoenix, Arizona 85036.

The VHF Amateur

This informal, well-illustrated book is based upon Robert Brown's magazine "The VHF Amateur," which was the only monthly VHF magazine for a period of five years. Also titled "The VHF Amateur," the book

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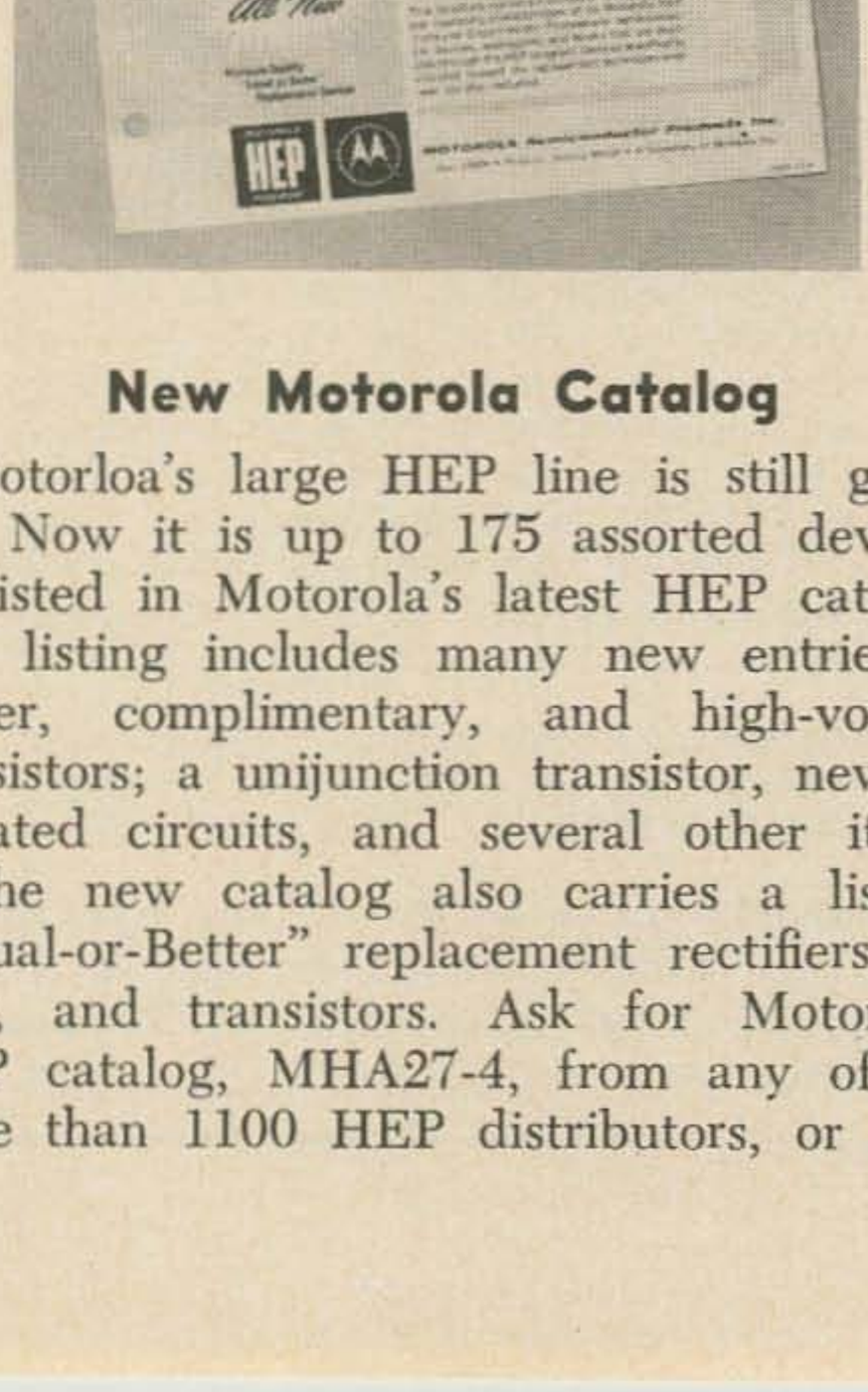
contains several projects from the magazine including some unusual antenna systems and details on two surface-wave transmission lines. This is the arrangement sometimes known as the "G-string."

Several pages are devoted to the construction of two styles of pen recorders, which are useful for moonbounce and space communications experiments. Some of the problems of antenna tilting are discussed also.

The popular Heathkit "Twoer" comes in for a discussion of possible further circuit development, and there are some notes on APX-6 conversion.

Other material includes schematics of TV tuners that may be converted for VHF applications, a very inexpensive 2-meter receiver, a 2-meter sideband transmitter and several other VHF projects.

Available from distributors or from Editors and Engineers Ltd., New Augusta, Indiana for $4.50.



New Motorola Catalog

Motorloa's large HEP line is still growing. Now it is up to 175 assorted devices, all listed in Motorola's latest HEP catalog. The listing includes many new entries of power, complimentary, and high-voltage transistors; a unijunction transistor, new integrated circuits, and several other items.

The new catalog also carries a list of "Equal-or-Better" replacement rectifiers, zeners, and transistors. Ask for Motorola's HEP catalog, MHA27-4, from any of the more than 1100 HEP distributors, or from the Technical Information Center, Motorola Semiconductor Products Inc., PO Box 20924, Phoenix, Arizona 85036.

Omega-T Bridge

A radio antenna is something like an appliance plug you push into a wall socket when you want line power for a light or an iron. It has to fit, but the critical electrical sizes for the radio antenna are not visible to the eye.

Many simple and complex electronic instruments are marketed for antenna testing. Basically, they all do the same job, indicating when the antenna is properly adjusted. Most of them require additional instruments, and for some a transmitter is needed too. But here is an instrument that gets by with only the gear that will be available anyway: the antenna, and the receiver that is to be used with the antenna.

The Omega-T Bridge circuitry does the rest of the job. There is quite a lot of it inside that little box, which accounts for its price. This excellent investment will be valued by any worker who is trying to get the best performance from a transmitting or a receiving antenna. This recently developed improved model antenna bridge noise bridge is now available at $34.95 from Omega T Systems, Inc., 516 W. Belt Line Rd., Richardon, Texas 75080.

Tell Our Advertisers

You Saw It in 73

Micronta Binoculars

If you want to see what's going on up there in your tower, you can always pick up a handy pair of binoculars and look if you can find some binoculars.

Radio Shack has introduced a line of low-priced binoculars that are available in three varieties: normal, wide angle, and extra wide angle. All are the same magnification and size, 7 x 35, but offer fields 341, 525 and 578 feet wide respectively at 1000 yards.

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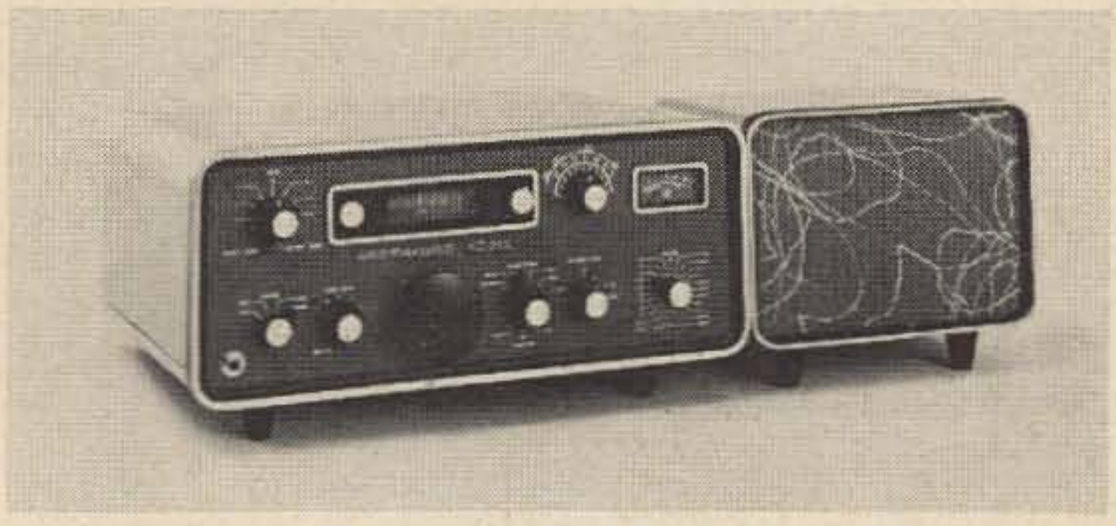
Priced at $19.95, $24.95, and $29.95 (for the widest field) the binoculars may be obtained from Radio Shack, 730 Commonwealth Ave., Boston, Mass. 02215 if they are not available locally.



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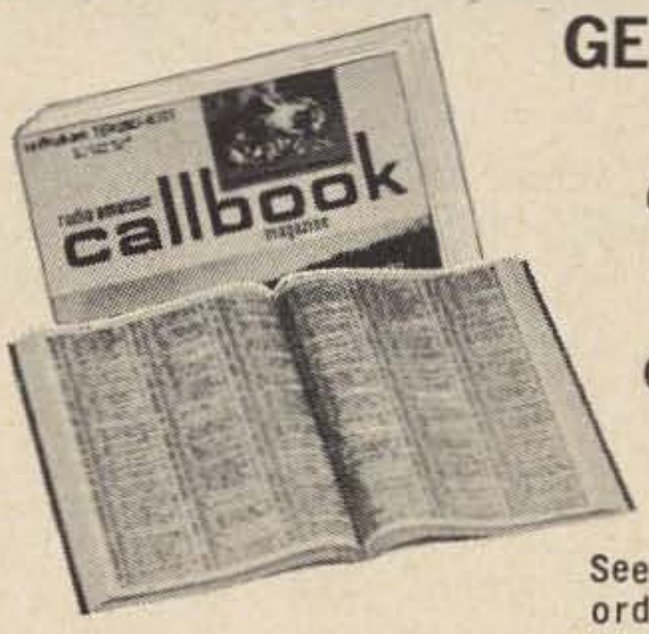

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dial with 22 inches of scale for a dial accuracy of plus/minus 200 cycles. Sensitivity is better than 0.5 microvolts for a 10 db signal to signal-plus-noise ratio. The HQ-215 uses 26 silicon transistors, 13 diodes and two zener regulators. It is supplied with one 2.1 kHz filter and has provision for two more.

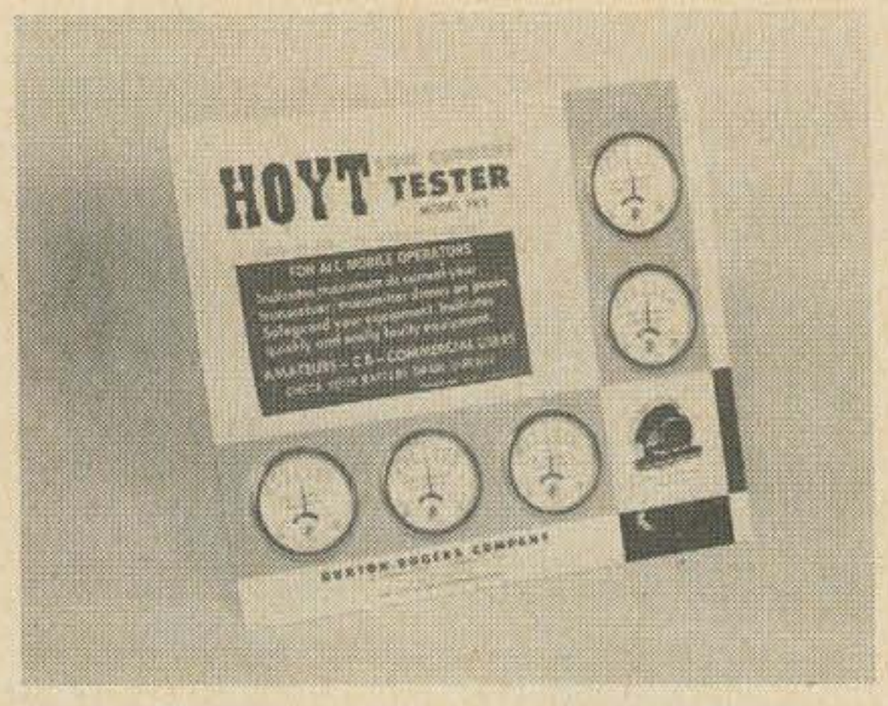
Price is $529.50 with a matching speaker at $24.95. For further information write to Irving Strauber, W4KXD, Hammarlund Manufacturing Co., Mars Hill, North Carolina 28754

Response Tailored Microphone

Modern electronic devices and circuits tend to be inherently wideband. Additional circuit components are often required to reduce frequency response to that appropriate for most effective communications, but an alternative is to avoid introducing the unwanted frequencies into the circuit at all.

Altec Lansing's Model 650A cardioid dynamic microphone is specially designed for a limited frequency response. Its high frequency cutoff is fixed at 14 kHz, but the low-frequency response can be switched to either 50 or 400 Hz. And its cardioid response feature makes it far less susceptible than ordinary microphones to picking up interference and unwanted crowd noises originating from the side opposite the speaker. Front to back discrimination is 20 db.

The amateur net price is $75.00. For further details write to Don Palmquist, Altec Lansing, 1515 South Manchester Ave., Anaheim, Calif. 92803.

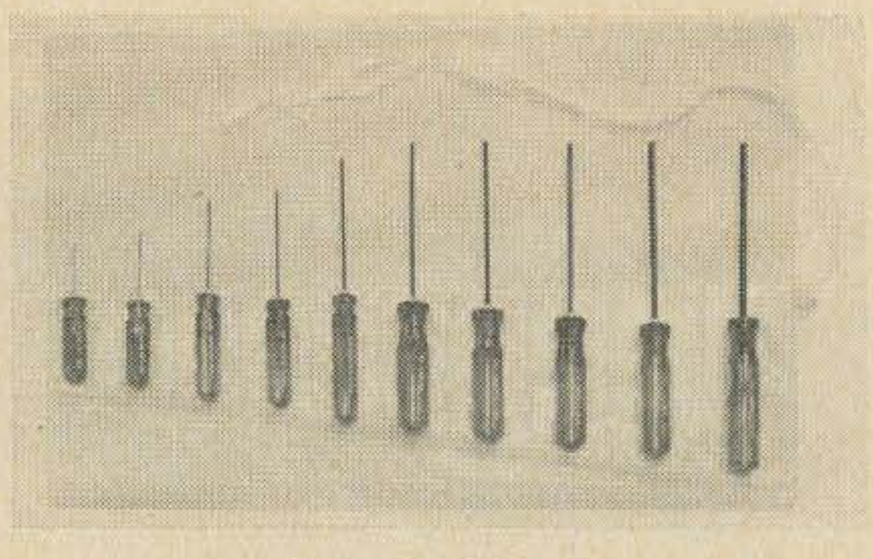


Hoyt DC Current Gauge

A part of good planning in mobile rig installation is to be sure where all the generator currents are flowing, and to know what the various operating currents really are. A conservative generator designer may have allowed no more than enough capacity for your rig, or perhaps somehow the battery runs down too much and it is not very clear what the trouble is. Such questions are best answered by measurements, but it may be difficult to break into the circuit at several different points. Hoyt's new current test meter makes this surgery unnecessary.

This convenient induction indicator responds to the magnetic field around a wire carrying up to 30 amperes. It will give a usable response to as little as one or two amperes, and indicates either direction of current flow. Without any cutting, you simply hold the meter against the wire.

Supplied five to the display card. Try your distributor for radio or automotive supplies, or write to the Burton-Rogers Co., 42 Carleton St., Cambridge, Mass. 02142.



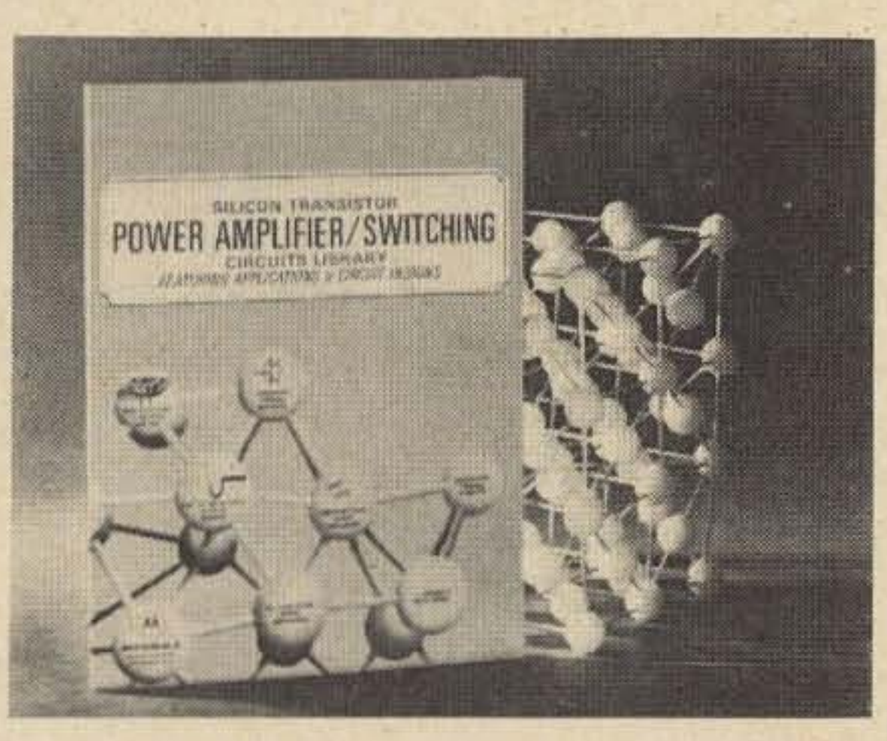
Small Tools

Hunter Industries is manufacturing a complete line of small and special-purpose tools for electronics assembly work. Some of these tools resemble but are imaginatively different from those you might find in your hardware store. For instance, the simple hex screwdrivers pictured above are not very

generally available, yet any bench worker knows hex nuts are pretty common in electronics gear. Think about having a set of hex drivers in your lab, and then write to Hunter Industries, 9851 Alburtis Ave., Santa Fe Springs, Calif. 90670.

Motorola Condensed Catalog

Motorola Semiconductors' new 1968 Condensed Catalog is an excellent hunting ground for bench-working hams looking for news about new semiconductor devices. It will be very interesting to electronics writers, too. It contains major specs on more than 3500 of Motorola's semiconductor types, and order information on about 9000 more. Semiconductor device mechanical dimensions are also given. Write to Department TIC, Motorola Semiconductor Products Inc., Box 13408, Phoenix, Arizona 85002.



Power Transistors Book

The growing importance of power transistor technology is becoming apparent in the higher-power and higher-frequency specs continually appearing in the engineering publications. Now Motorola has published an eighteen-section volume of technical literature describing applications for silicon power transistors.

Consumer and industrial applications are discussed, and the material is directed to users with less deep technical knowledge as well as to the trained engineer. A Selection Guide covers about 100 plastic and metal transistor types ranging from 3.75 watts to 200 watts dissipation.

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Sudden UFO Interest Not Restricted To Hams

Ken W. Sessions, Jr. K6MVH
Technical Editor
Electro-Optical Systems, Inc.
300 N. Halstead
Pasadena, California

The radio amateur's interest in flying saucers may be more timely than one might at first suspect, for a similar interest was recently announced in Russia, a country with an earned record of ignoring such space phenomena. And when Russia takes a look at the world of flying saucers, that IS news! In what amounts to a complete reversal of official attitude toward flying saucers, Russia now rejects the tired explanations we Americans are accustomed to hearing: that UFO's are the result of "optical phenomena" and that they are quasi-natural occurrences of atmospheric or terrestrial origin. Russian scientists now go on record as offering their learned support to the hypothesis that UFO's originate on at least one other world somewhere in space.

In articles appearing in "Kimsomol'skaya pravda" and 'Teknika-Molodezhi," the Russian scientific community let pass a sequence of startling announcements that tend to confirm the need for a world-wide amateur radio "skywatch" plan. Included was a convincing conjecture that the famed Tungusky meteorite of 1908 was an artificial craft from another planet.

Information as to the contents of the two Russian scientific publications was released by Electro-Optical Systems, Inc., an aerospace firm in Pasadena, California, in a house-organ series entitled "Soviet Science in the News." The California firm, a subsidiary of the Xerox Corporation, makes regular translations of Soviet technical papers as a service to American scientists.

According to the Russian-to-English translation of the Soviet papers, there has been a number of recent Soviet investigations by the USSR's Academy of Sciences with respect to the Tungusky meteorite. The Tungusky explosion, the report said, had **every parameter** of an atmospheric nuclear blast and left considerable residual radioactivity. Also lending credence to the Soviet Academy's theory was the fact that the "meteorite" had apparently maneuvered immediately preceding the blast. The mysterious body exploded after apparently negotiating a 375-mile arc in the earth's atmosphere.

While the Russian's sudden interest in UFO's as a very real element of our times does not necessarily mean all old theories must be discarded, it does help to maintain an aura of sobriety in the discussion of a subject once reserved for the lunatic fringe.

. . . K6MVH

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Around The World

Algeria

Although the amount of equipment available is very limited as a result of strict regulations and an embargo on sending money out of the country, more licenses are expected to be issued shortly. At the present time there are 15 licensed stations in Algeria, seven held by nationals (7X2), five by foreigners (7X0), and three by club stations (7X2 plus three letters).

Five stations are active on 144 MHz, working into France, Italy and Spain. There is interest in SSB, RTTY and TV, but the equipment is just not available.

Bulgaria

During November a 15 day seminar was held in Sofia for instructors in Amateur Radio in order to help them improve their methods of teaching the theory of electronics. Operating practices for VHF and short wave, contest operating, construction practice, fox-hunting and the organization, conducting and judging of competitions were also discussed.

In December each of the 32 District Radio Clubs met in Sofia for a 15 day course on fox-hunting. Each participant had to build three fox-hunting transmitters for 3.5 and 144 MHz.

A special Jubilee International LZ DX Contest will be held on September 14, 1969 from 0000 to 1200 GMT on CW and SSB to mark the 25th anniversary of the Republic.

ITU—Geneva

The Administrative Council of the ITU has announced the intention to hold a World Administrative Conference in the latter part of 1970 to deal specifically with Space Radio Communications, Problems and Allocations. The exact dates, location and detailed agenda will be decided by the Council in May 1969.

Faroes

The annual meeting of the FRA was held in Thorshaven in October 1968. An activity contest was announced starting 1 Nov and ending 30 April 1969 on all bands, 3.5 to 28 MHz.

Italy

Radio manufacturers and dealers in Italy are required by law to provide purchasers of radio transmitters with a government certificate setting out the frequencies on which the transmitter may be operated and the maximum power that may be used. Just how this will affect home made equipment is not yet known. The small 11 meter Japanese walkie-talkies may give the authorities fits since many of them run well over the 10 mw permitted by law.

The ARI has petitioned their PTT for permission to operate in the 431.75-432.25 MHz band.

Netherlands

The Netherlands Government has extended its reciprocal operating agreement with the U.S. to include Surinam (PZ) and the Netherland Antilles (PJ), as well as the homeland.

Every Friday evening at 2030 GMT VERON transmits a broadcast in English on 14.1 MHz on RTTY. Reports will be appreciated.

Nigeria

The war with Biafra has held up the issuance of new amateur licenses. At present only stations in Lagos, Kaduna and Zaria can operate. Four members of the NARS are on the staff of the university at Zaria and a strong effort is being made to encourage students to take up amateur radio as a hobby. The SSB station at the university is 5N2AAU and is active.

Norway

The annual meeting of the NRRL took place in August. There are 2379 licensed amateurs in Norway, 258 more than the previous year.

A fund has been set up, with the aid of a government grant of $2100, to help the handicapped to become radio amateurs. IRC's for contacts with LG5LG will also go to this fund. This station has been set up in the Free State of Morokulien, an area surrounding the Peace Monument set up on the Norwegian-Swedish border. Send 3 IRC's for QSL or 4 IRC's for a direct QSL. Send $3.50 for an Honorary Citizenship in the Free State of Morokulien to the NRRL, Box 21, Refstad, Oslo 5, Norway.

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Quick and Easy QRP

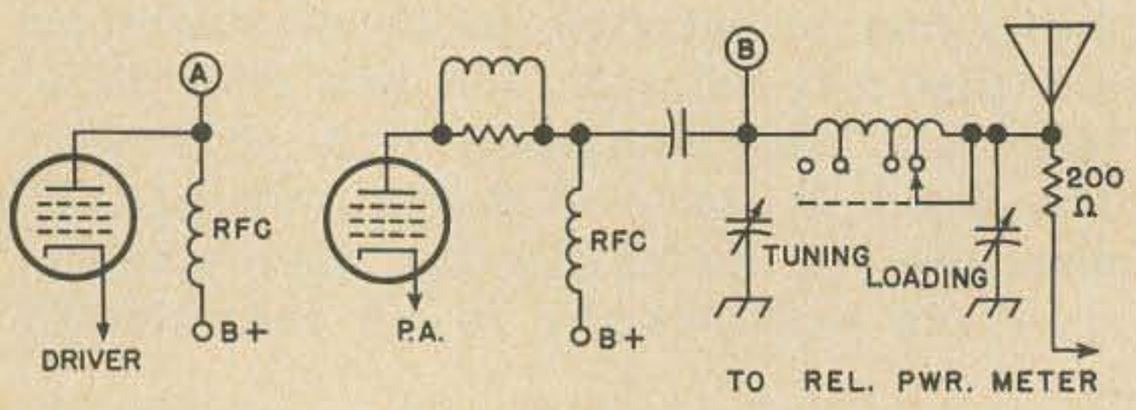

Fig. 1. External conversion of a VFO by adding an antenna coupler, a relative power output meter, and a TR switch.

Nearly every month one sees articles in ham magazines about some low power transistor transmitter. Have you ever had a desire to build such a rig but never got around to winding the coils or sending away for the transistors? But your laziness (and mine!) shouldn't stop you from enjoying QRP operations. This article describes two simple ways of using equipment in your shack to get you on QRP in a single evening.

In Method I a VFO is converted (externally) by adding an antenna coupler, a relative power output meter, and TR switch (See **Fig. 1**). If you don't have a separate VFO, Method II describes conversion of a medium power transmitter by removing the finals and connecting the driver to the pi-net (**Fig. 2**). I don't recommend crystal controlled low power operation, but it must be possible.

The modern VFO is actually a low power transmitter. It provides a fundamental on 80 and 40 meters and harmonics on 20, 15, and 10. It can be keyed from a terminal strip or jack on the back. The *rf* output is carried out through coax to the transmitter, or in this case, the antenna. The *rf* passes through a harmonic filter-antenna coupler, which consists of a tuned circuit LI-CL. LI is 30 turns of enameled wire, hook up close-wound on a 1 inch diameter cardboard tube. 13 turns are shorted out for 40 meters by S1. C1 was a 100 pF variable, but a standard 365 pF variable will do, though tuning will be a little more difficult.

The relative power output meter is fairly standard. The 5K pot, the sensitivity control, limits the amount of *rf* to the rectifier and filter. C1 is tuned for maximum indication on the milliameter. Keep the reading low, as the current you read on the meter is not reaching the antenna.

With this setup, using an HA-5 VFO running five watts input,, I have worked into PEI (579) and Michigan (569); each over 700 miles away. Don't expect fantastic reports, but expect to get out. The number one requirement for QRP work is patience. You will probably not get an answer the first time, or even the second time. It takes a good ham at the other end to even bother to copy your station.

Remember that if your neighbor is running 100 watts,, medium power, you are 13 db below him to start, a little over 2 S units. Don't lose any power in your coax or dipole. My dipole, left over from my novice days, was resonant at about 7175 kHz. As this frequency was approached from the low end of 40 the relative output meter nearly doubled it's reading.

Also of prime importance is your receiver. If you want someone to copy you out of the noise, you must be able to do the same.

And just a word about operating. I wouldn't recommend sending CQ too much. It's better to come back to a CQ right where you can be easily found.

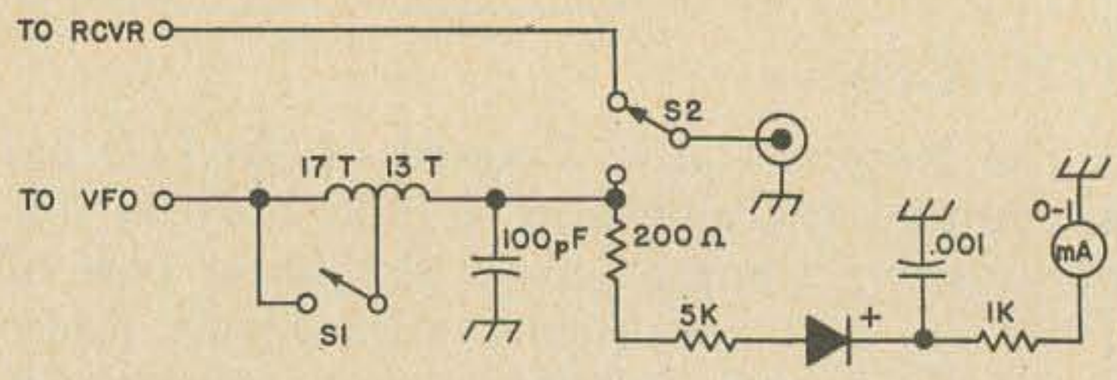

Fig. 2. Conversion of a medium power transmitter by removing the finals and connecting the driver to the pi-net.

Fig. 2 shows the final stage of a CW transmitter. Remove that big, ugly final. Connect a 1000 pF mica capacitor from the point A (the plate pin of the driver) to point B (the input of the pi-net). Since you can no longer tune up by plate current, you must add the relative power output meter circuit, or, in the case of a rig that already has one (like the T150A, which I modified), increase it's sensitivity. This can be done by decreasing the value of the dropping resistor that goes to the antenna jack to about 500 ohms. If the meter circuit is to be added connect the 200 ohm resistor as close as possible to the antenna, and bring a pair of twisted wires out to the pot.

This method offers the advantage of working all bands. Fifteen meters is an especially good band for low power. With fifteen watts input in a T150A I was 599 in Texas, about 2200 miles away. But 15 watts is high power.

Just a few more things. QRP offers a new challenge to hams. Like DXing, which is all it really is (though I've ragchewed for over an hour while my lunch was rapidly cooling) the antenna system must be perfect, for best results. Extreme patience is required, as well as a stable, selective receiver, and a good operator.

If you've ever had any TVI complaints, you won't now. Your rig is no longer strong enough to interfere!

A kindly OM was down at the shack the other day, and, being favorably impressed, made the following encouraging comment: "Why don't you plate-modulate the VFO? Take an audio transformer, hook it up backwards to the hifi, put the primary in series with the B+ to the plate of your final, and . . . He hasn't been invited back.

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ARGENTINA	14	14	14	7A	7A	7	14A	21A	21A	21A	21A	21A
AUSTRALIA	21A	14	7B	7B	7B	7B	7B	14B	14A	14A	21A	21A
CANAL ZONE	14A	14	7A	7	7	7	14	21A	28	28	21A	21
ENGLAND	7	7	7	7	7	7B	14A	28	28	21	14	7B
HAWAII	21A	14	7B	7	7	7	7	7B	14	21A	28	28
INDIA	7	7	7B	7B	7B	7B	14	14A	14	7B	7B	7B
JAPAN	14	14	7B	7B	7	7	7	7B	7B	7B	7B	14
MEXICO	14	14	7	7	7	7	7A	14A	21A	28	21A	21A
PHILIPPINES	14	14	7B	7B	7B	7B	7	14B	7B	7B	7B	7B
PUERTO RICO	14	7	7	7	7	7	14	21A	21A	21A	21	21
SOUTH AFRICA	14	7	7	7	7B	14	21	28	28	21A	21A	21
U. S. S. R.	7	7	7	7	7	7B	14	21A	14	7B	7B	7
WEST COAST	21	14	7	7	7	7	7	14	21A	28	28	28

CENTRAL UNITED STATES TO:

ALASKA	21	14	7	7	7	7	7	7	7A	14A	21A	28
ARGENTINA	21	14	14	7A	7A	7	14	21A	21A	21A	21A	21A
AUSTRALIA	21A	14	14	7B	7B	7B	7B	7B	14A	14A	21A	21A
CANAL ZONE	21	14	14	7A	7A	7	14	21A	28	28	28	21A
ENGLAND	7B	7	7	7	7	7	7B	14A	21A	21	14	7B
HAWAII	21A	14	14	7	7	7	7	7	14A	21A	28	28
INDIA	7B	14	7B	7B	7B	7B	7B	7B	14	7B	7B	7B
JAPAN	21	14	7B	7B	7B	7	7	7	7B	7B	7B	14
MEXICO	14A	14	7	7	7	7	7	14	21A	21A	21	21
PHILIPPINES	21A	14	7B	7B	7B	7B	7	7	7B	7B	7B	14
PUERTO RICO	14	14	7	7	7	7	14	21A	21A	21A	21A	21
SOUTH AFRICA	14	14B	7	7	7B	7B	14	21A	28	28	28	21
U. S. S. R.	7B	7	7	7	7	7B	7B	14	14	7B	7B	7B

WESTERN UNITED STATES TO:

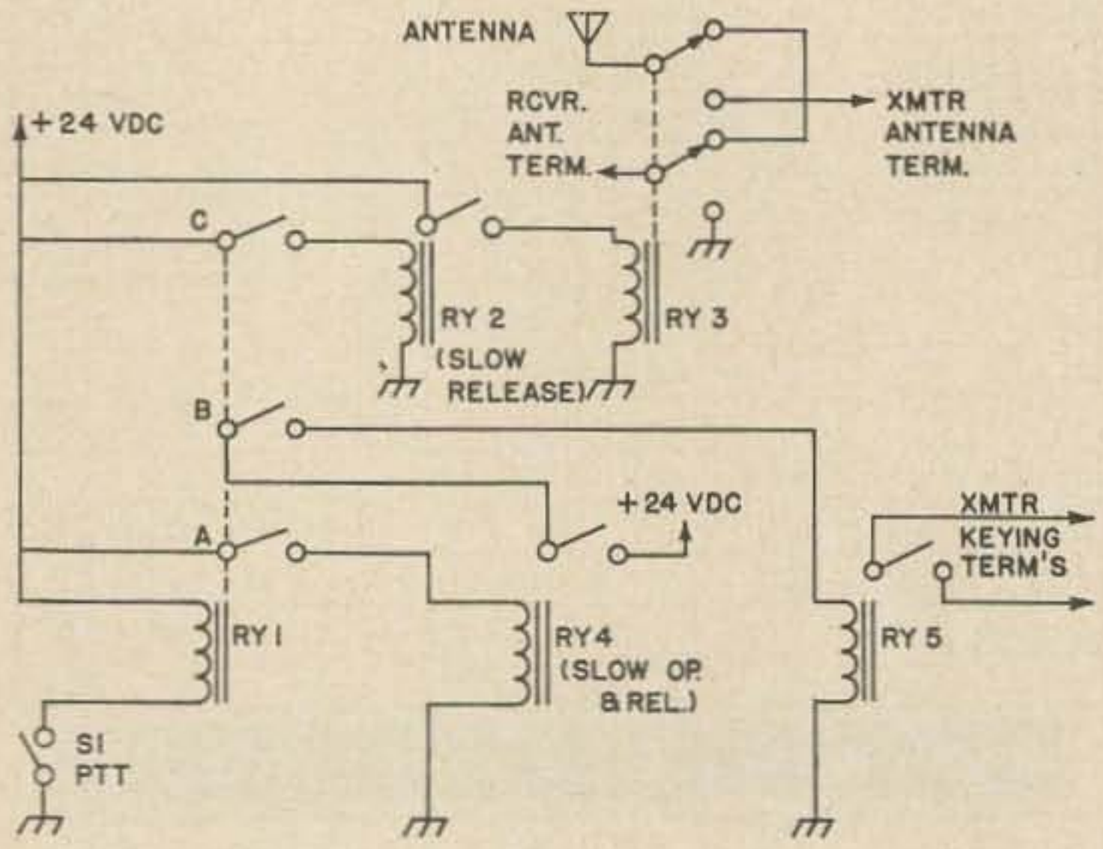
ALASKA	21	14	7	7	3A	7	7	3A	7	14	21	21A
ARGENTINA	21	14	14	7A	7A	7	7	14A	21A	21A	21A	21A
AUSTRALIA	21A	21A	14	14	7	7	7	7	14	14A	21	21
CANAL ZONE	21	14	14	7	7	7	7	14A	28	28	28	21A
ENGLAND	7B	7	7	7	7	7	7B	7B	14A	14A	14	7B
HAWAII	28	21A	14	14	7	7	7	7	14	21A	28	28
INDIA	7B	14A	7B	7B	7B	7B	7B	7	7	7B	7B	7B
JAPAN	28	21	14	7	7	7	7	7	7	7B	14B	21
MEXICO	21	14	7	7	7	7	7	14	21A	28	28	21A
PHILIPPINES	21A	21	14	7B	7B	7B	7B	7	7	14B	7B	14
PUERTO RICO	21	14	14	7	7	7	7	14A	21A	21A	21A	21A
SOUTH AFRICA	14	14B	7	7	7B	7B	7B	14	21A	21A	21A	21
U. S. S. R.	7B	7	7	7	7	7B	7B	7B	14	7B	7B	7B
EAST COAST	21	14	7	7	7	7	7	14	21A	28	28	28

A - Next higher frequency may be useful also.
B - Difficult circuit this period.

Good: 1, 2, 4-6, 9-12, 14, 16-18, 23-25, 27-30
Fair: 3, 8, 13, 15, 21, 22, 26
Poor: 7, 19, 20

Douglas Byrne G3KPO
Jersey House
Peterborough, England

Full Sequential Switching with Simple Relays



Low-noise transistors in receiver front-ends are mighty fine and have a long, care-free life-provided, and only provided, they are not given a knockout blow from the transmitter rf.

This is all too easy to do at many amateur stations, and for absolute safety it is vital for the control-system to incorporate some form of sequential switching.

Good designs have been published, for instance "Ultimate Station Control" by W2AJW in 73 for Sept. 66, but most involve the use of many transistors or scarce high-resistance relays—and by Murphy's Law, the special type required is never available.

However, there are plenty of surplus 24-volt relays in all self-respecting junk-boxes, and this particular station control-system uses nothing else. In spite of its obvious simplicity, it gives full sequential switching, thereby automatically protecting those expensive front end transistors by making sure the receiver input is grounded and the antenna transferred to the transmitter well before the B-plus is applied to the PA final. And just as important, it sees to it that the B-plus is switched off before the antenna is returned to the receiver input.

Additional advantages are that all antenna switching is done "cold", without rf on the feeders, the transmitter output is always looking into a load, and when the control system is off, the antenna is connected to the receiver—all ready for a quick listen round the bands.

Details of relays

The relays required all have normal sets of contacts, which are "open" in the de-energised position.

RY1, which is the main control, has three such pairs (plus any additional ones which might be useful for killing the receiver B-plus).

RY2 is slugged with a copper ring round the heel or bottom end, as in **Fig. 2a,** and this causes it to be slow to release. If you do not happen to have one of this type around, quit worrying. Simply connect a small diode rectifier across the relay coil—the right way round as in **Fig. 3a,** so that it merely short-circuits the induced EMF, and not the applied voltage. Alternately, wire a resistor across the coil—about the same value as that of the coil—as **Fig. 3b.** Either will delay the release when put across an ordinary relay.

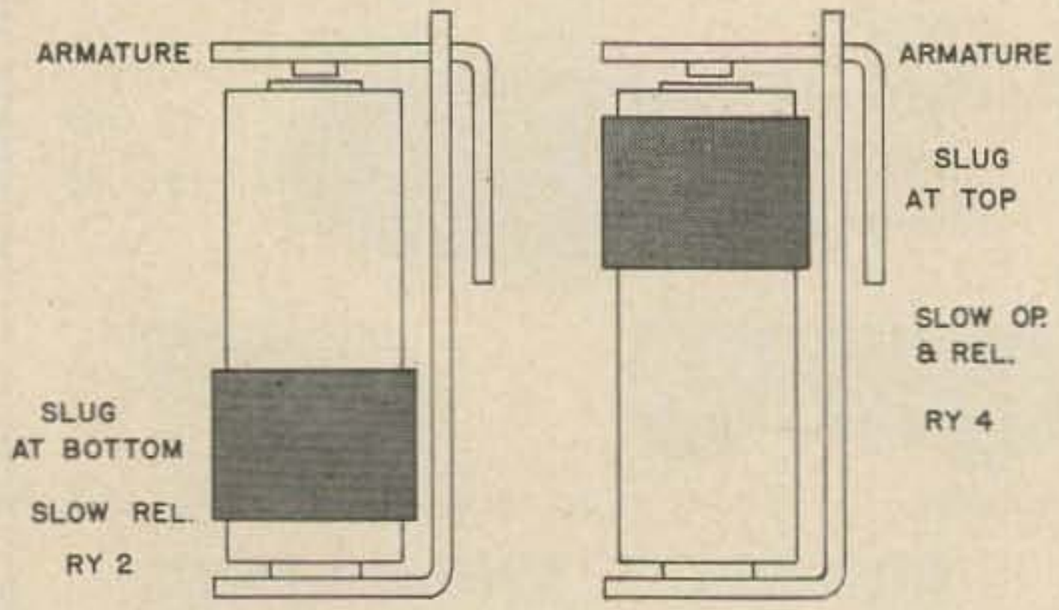


Fig. 2. See Text.

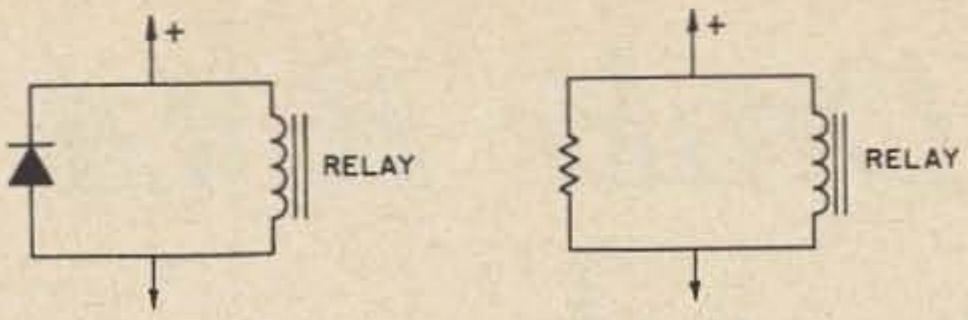


Fig. 3. See Text.

VY3 is the usual transmitter antenna changeover relay.

RY4 is another slugged type, but this time with the copper ring at the toe or top end –next the armature. This makes it slow to operate as well as to release. See **Fig. 2b.**

Finally, RY5 is the transmitter B-plus relay.

Modus operandi

S1, the PTT switch, activates RY1, and current is fed via the "A" contacts to RY2, which closes immediately as it is only slugged for delay on release. So RY3, the antenna change-over relay, is energised without any appreciable time lapse. Receiver input is grounded, and antenna switched to transmitter.

Current is also fed via the "C" contacts on RY1 to RY4, which is slugged to give a time delay in both operate and release modes. So here is there is a time lag before current is fed via the "B" contacts on RY1 to RY5–to turn on the transmitter B-plus.

In the reverse action, S1 is opened, RY1 de-energised, voltage removed from RY2, but –as this has a delayed release–it keeps its contacts closed for a short space of time. So current is still supplied to RY3, and the antenna remains switched to the transmitter for a little while.

Now, although RY4 is slugged and so has a delayed action, the supply of current to RY5 is via the contacts "b" on RY1. And these open immediately after S1 is opened, so the B-plus is removed from the transmitter before the antenna is switched over to the receiver. Result is safety, and long life to your expensive front-end transistors!

...G3KPO.

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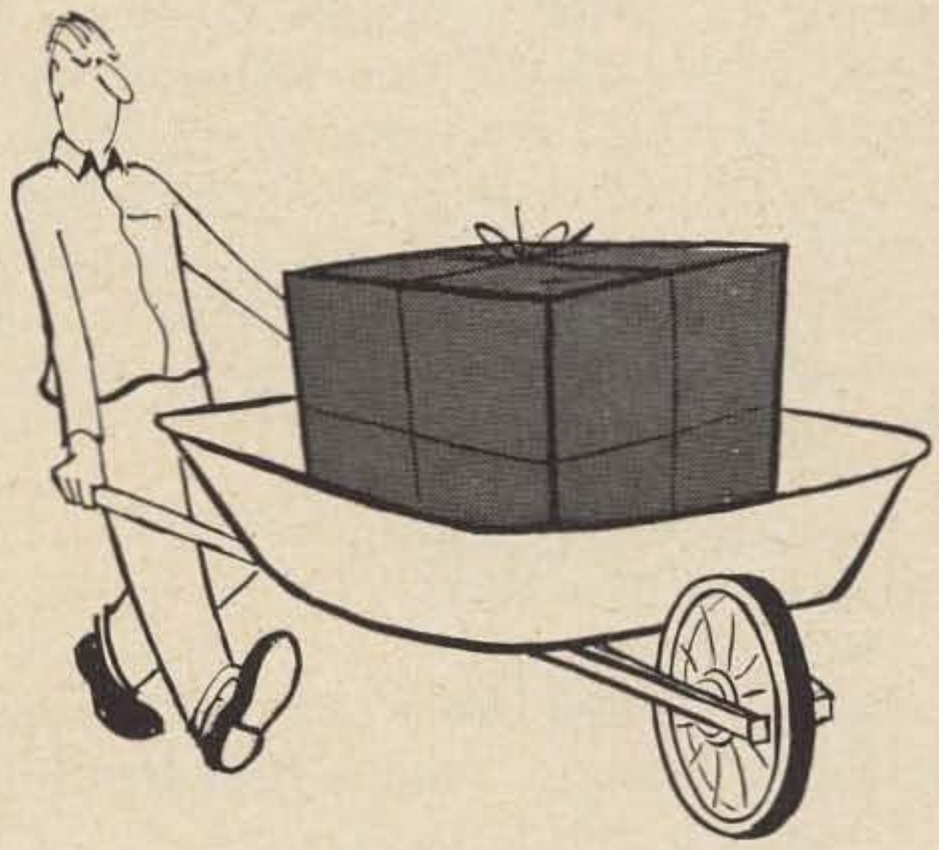

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NEW HAMPSHIRE 03458

Report on the Drake R-4A Receiver and T-4X Transmitter

Fred W. Fetner, Jr. WB4EFA
1728 *Ebenport Road*
Rock Hill, S.C. 29730

After getting off to a bad start with an inexpensive receiver which proved to be unsatisfactory, I decided to purchase a really good receiver. For some time I studied the specifications of the available receivers but overlooked the Drake for some unknown reason. One day, I read the specifications of the Drake Receiver and was astonished by its many features. After much comparison with other receivers I found that I could find no other receiver at any price with all of the following features:

1. Permeability tuning
2. Transistorized VFO
3. Passband Tuning
4. Crystal lattice filter in first *if* stage
5. Highly selective and adjustable tuned circuits in 2nd *if* stage.
6. Noise blanker as standard (not optional) equipment (not merely a noise limiter)
7. 1 kHz tuning accuracy
8. Notch filter
9. Auxilary band coverage capabilities

I bought my R-4A in April 1967 and was immediately impressed by its good appearance which somehow is not done justice by the catalog pictures of it. I also noticed its extreme quietness. The stability is remarkable. No drift has ever been detected even from a cold start. My homemade CW crystal controlled transmitter has more drift than the R-4A. No retuning has ever been needed. The skirt selectivity is amazing with any normal S-9 signal more than 1 kHz away being inaudible. After using the receiver for a while I began to wonder if the unit was more selective than the standard communications receiver employing a sharp CW crystal filter. So I got such a receiver on loan and used it and found that while it had a very pronounced peak the skirt selectivity was not nearly as good as that of the R-4A and that overall the R-4A was vastly superior and more selective, and much easier to tune.

The Drake has passband tuning which makes it superior to any receiver which does not have this feature. This is an adjustable or tunable circuit in the 2nd *if* stage which may be tuned over a 6 kHz range. The receiver frequency is not changed by the passband tuning control, the control merely selects and peaks the desired frequency out of the 6 kHz wide signal which comes through the crystal filter in the first *if* stage. The lattice filter provides the immunization against cross modulation from nearby powerful stations, and the skirt selectivity and the passband tuning system provides the actual main selectivity which is adjustable from 4.8 kHz to .4 kHz in four steps. 2.4 kHz and 1.2 kHz is provided for SSB use. Upper or lower sideband selection is also made with the passband tuning control. The control can be used to select any one of several stations near the same frequency without having to move the main tuning knob. There is little chance of losing a signal on CW since once the station is heard, the main tuning can be left unmoved and the signal peaked by using the passband control. No variable BFO is used, and none needed, since after peaking one signal all further signals come in at the same audio pitch. By using the high selectivity, Effective T notch filter and switching to the opposite sideband, if necessary, it is rare indeed that a station cannot be copied through QRM. Many times my contacts have referred to QRM on their end and I have replied that they are 599 with no QRM. Some of this is due to the different locations, but most of it is due to the selectivity of the receiver.

The noise blanker eliminates most man-made type interferrence completely but has little effect upon static. Setting the T notch

filter slightly off to one side of the desired signal helps somewhat in copying under heavy static conditions.

Turning the passband control to the center position or slightly to one side of center makes weak CW signals come in stronger and for extreme QRM conditions setting the control toward the extreme right or left position increases the selectivity while making the receiver less sensitive. For SSB the 2.4 kHz position is provided and for extreme QRM conditions the 1.2 kHz position works wonders.

The main dial is marked in 25 kHz increments and a skirt on the main tuning knob is marked in 0 to 25 kHz increments. The claimed accuracy is within 1 kHz across the dial but I have found it to be better than claimed. The calibration holds within about 200 Hz from band to band. Resettability is perfect. No backlash or slack exists.

Drake T-4X

When I purchased the receiver I had no idea that I would ever get the matching transmitter. But after using the receiver for almost a year I was so impressed and pleased with it that I decided to get the T-4X. It has VOX, PTT, CW sidetone and operates at 200 watts on AM as well as SSB and CW. AGC is employed on SSB and eliminates overmodulation even though the gain might be turned to maximum. No TVI has been detected even to a portable TV sitting right next to the transmitter. It seems to pack quite a punch for 200 watts. I have received many 40 over S-9 reports and many people thought I must be using a linear. I am using a dipole mounted about 15 feet high.

The real beauty of the combination is its flexibility of frequency control. At the mere flip of one switch separate frequency control can be obtained or transceive operation can be selected with either the receiver or the transmitter controlling both units. One VFO can be left in the CW band and the other in the phone band and the proper VFO is selected instead of retuning across the band.

The extra VFO is very useful in finding a clear frequency while the other VFO is left set on the frequency of the person you are working at the moment.

Of course, if someone starts drifting you can switch to separate frequency control to stay with him with your receiver without altering the transmitted frequency.

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The new T-4XB and R-4B appear to use the same basic circuits with certain improvements such as: a 50 kHz calibrator for sub-band marking, and a newer and better crystal lattice filter in the transmitter for even better sideband suppression. They also have a new tuning knob and knob skirt or dial and a new chip resistant paint finish.

If you will compare I think you will agree that none of the competition can equal the Drake Line.

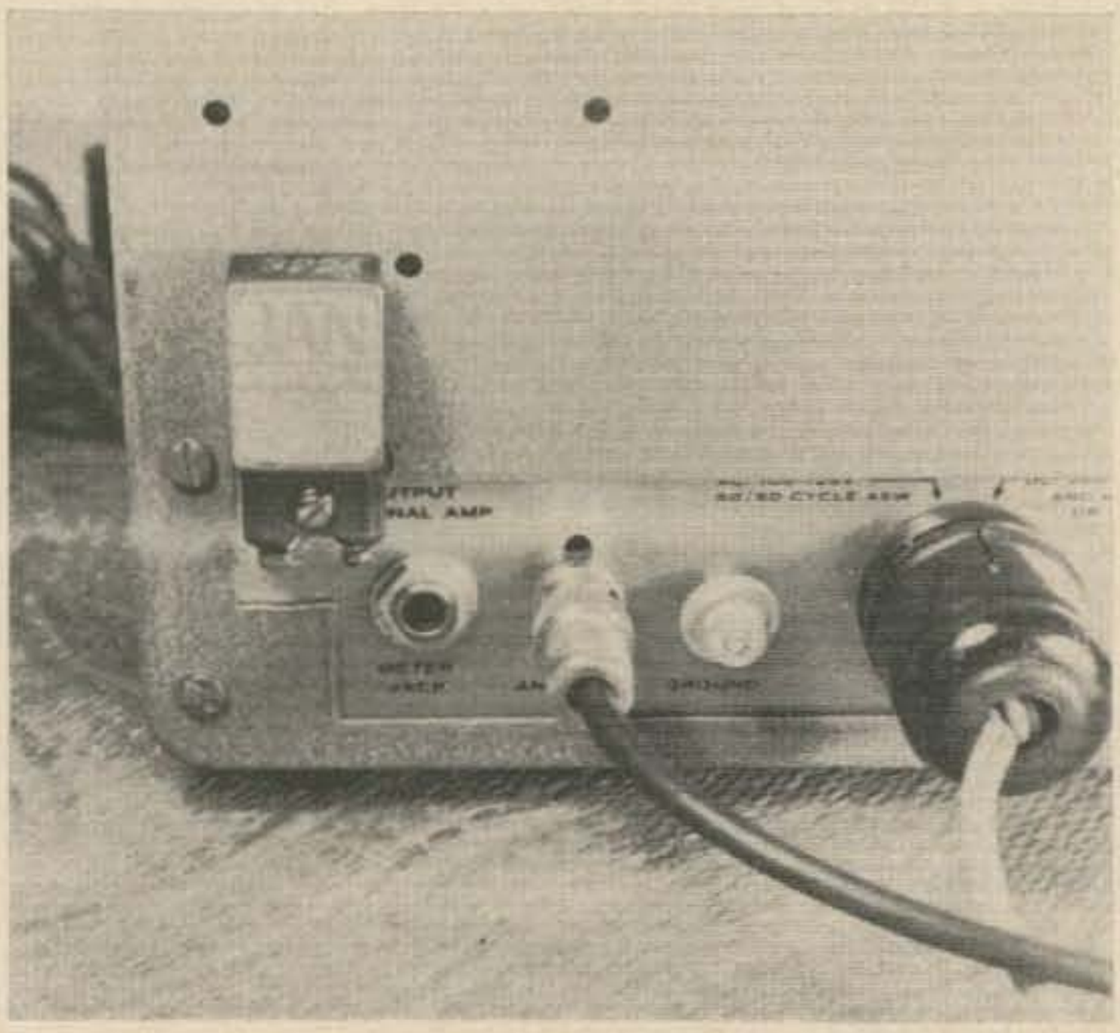
. . . WB4EFA

Operating Suggestions For The Two'er

E. H. Marriner W6BLZ
528 *Colima Street*
La Jolla, California

There have been numerous suggestions for improving the two meter Heathkit HW-30 transmitter-receiver also known as the Two'er. Here are some more suggestions.

In order to change crystal frequency it is necessary to remove the cabinet. The crystal originally is inside. A socket could be mounted on the front panel to remedy the situation, however, the long leads back to the original socket add so much capacity and inductance that the crystal may no longer oscillate. Some operators have solved the problem by cutting a square hole in the side of the cabinet. A better solution is to mount the crystal socket vertical at the back of the cabinet, and it does not take up much more space. A new .001 disk capacitor and a 22K 1 watt resistor will be needed because the new leads need to be slightly longer than the original components. To mount the crystal in the vertical position requires disk sanding a double type crystal socket down to the center hole. In other words do not cut the socket exactly in half. A number 41 drill hole is required



Mounting the crystal socket and the BNC coax socket.

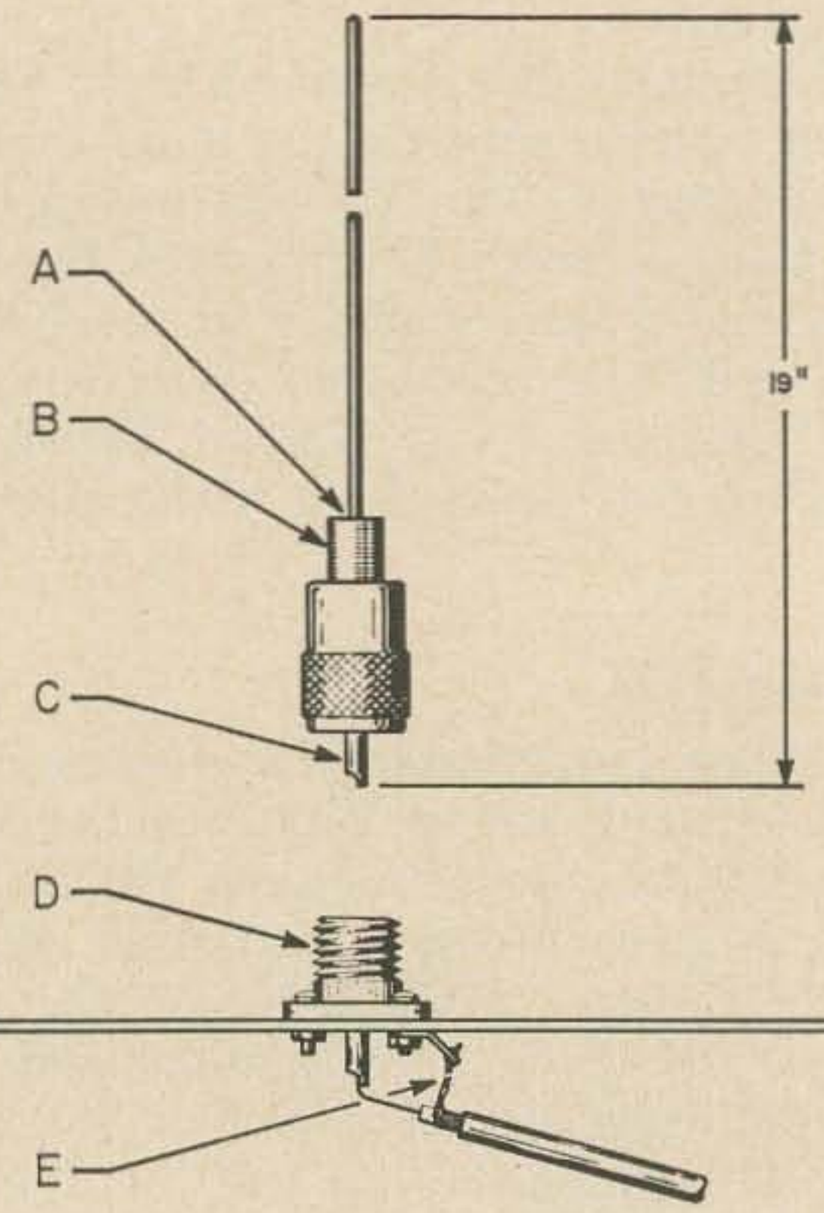


Fig. 1. Two meter antenna made from a type SO VHF coax plug.

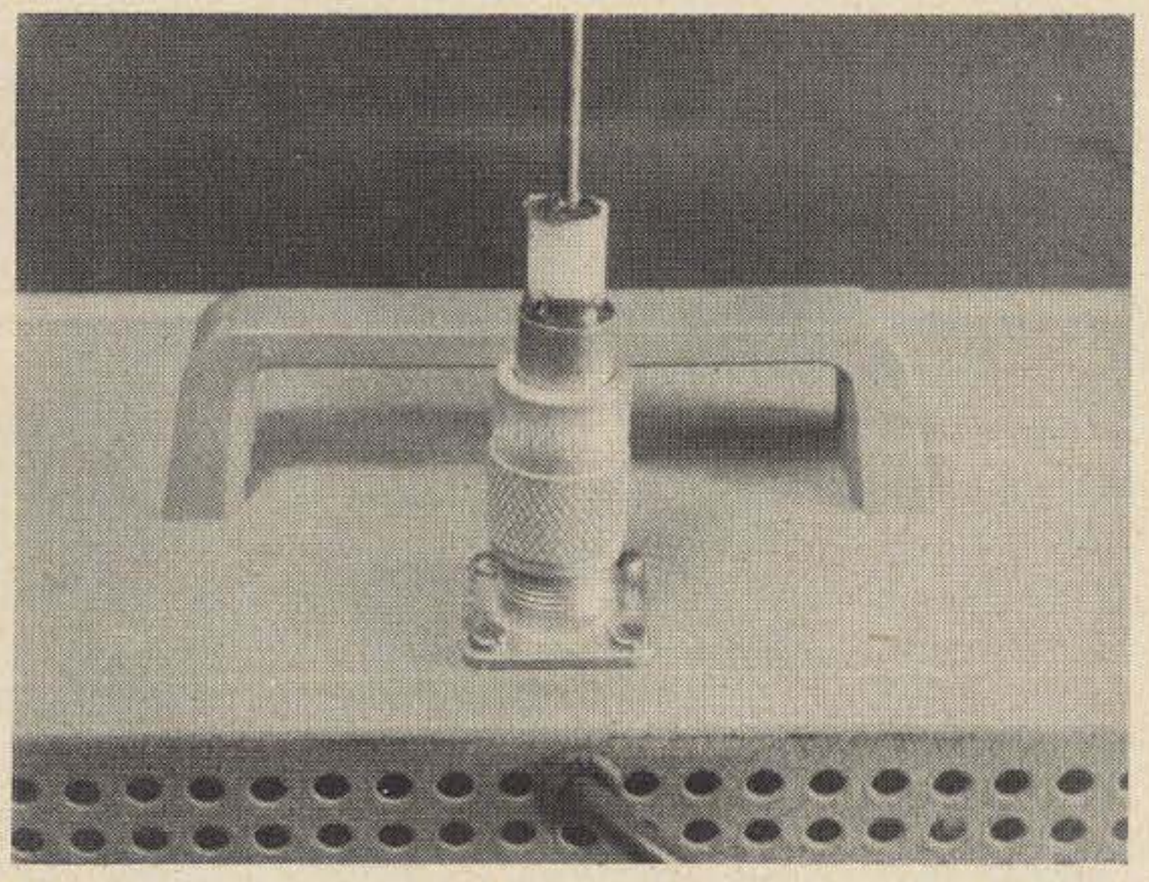
A. use a number 41 drill through the nylon center to accept the rod. B. ⅜x1" nylon slipped over rod after soldering. C. Brass rod pushed in and soldered here. D. Plug installed on top of the Two'er cabinet. E. Coax braid soldered to lug.

through the side of the socket to fasten it to the back of the chassis. A dab of Armstrong cement will help the screw secure the socket in a solid position. Two tiny holes are now drilled through the chassis for the leads of the 22K and .001 mfd capacitor whose leads have been covered with Teflon type spaghetti insulation to prevent shorting of the leads to the chassis. To change crystals now only requires peering around the corner of the cabinet to pull the crystal out and to plug in another.

Another improvement to the Two'er is to replace the phono type *rf* output socket with

Frequency	Crystal
144.000	8000 kc/s
144.18	8010 kc/s
144.45	8025 kc/s
144.7	8040 kc/s
144.9	8050 kc/s
145.31	8073 kc/s
145.35	8075 kc/s
145.440	8080 kc/s
145.500	8083.3 kc/s
145.620	8090 kc/s
145.800	8100 kc/s
145.900	8106 kc/s
146.000	8111 kc/s
146.090	8116.7 kc/s
146.200	8225 kc/s
146.500	8140 kc/s
146.700	8150 kc/s
146.820	8156.6 kc/s
147.1	8173 kc/s
147.2	8175 kc/s
147.6	8200 kc/s
148.00	8227 kc/s

a BNC chassis mount type. This will make it easier to change the RG58/U antenna cable. To put in this fitting the hole will have to be enlarged to ⅜ inches and the fitting will push in and the nut can be fastened to the underside of the chassis.



Mounting the portable antenna on the Two'er cabinet.

For portable operation in the backyard or on the dining room table, a vertical 19 inch whip antenna can be made and mounted on top of the cabinet. (see **Fig. 1**) It is only necessary to punch a ⅝ inch hole on the top of the cabinet and then solder on a short piece of RG58/U, and push it out one of the vent holes at the back of the cabinet. Now attach a BNC type fitting to the short lead and push it in the new BNC chassis fitting. The antennas can be made from a piece of brazing rod which is pushed through a piece of nylon insulation and is later pushed down into the SO type fitting and cemented after the rod has been soldered to the plug pin.

Each time a new antenna is used on the set the final will have to be adjusted for maximum output a fact often overlooked by operators because the ceramic output capacitor is inside the cabinet. A small hole can be drilled on the side of the cabinet so that a tuning wand* can be inserted to tune the final amplifier while watching the 0-1 mA output meter plugged into the back of the cabinet.

While these suggestions may seem trivial, they may be of great help to the person not familiar with the two'er, and they certainly make operating of the two-er much easier.

. . . W6BLZ

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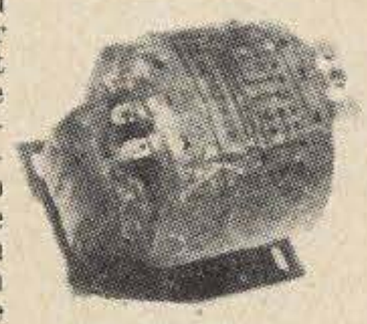

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John Allen, K1FWF, high school student, 51 Pine Plain Road, Wellesley, Mass. 02181. HF and VHF antennas, VHF transmitters and converters, AM, SSB, product data, and surplus.

Bert Littlehale, WA1FXS, 47 Cranston Drive, Groton, Conn. 06340. Novice transceivers, test equipment and homebrew projects gone wrong.

Bob Groh WA2CKY, BSEE, 123 Anthony Street, Rochester, New York 14619. Specializes in VHF/UHF solid-state power amplifiers, but will be glad to make comments on any subject.

G. H. Krauss, WA2GFP, BSEE, MSEE, 70-15 175 Street, Flushing, New York 11365. Will answer any questions, dc to microwave, state-of-the-art in all areas of communications circuit design, analysis and use. Offers help in TV, AM, SSB, novice transmitter and receivers, VHF antennas and converters, receivers, semiconductors, test equipment, digital techniques and product data.

Charles Marvin W8WEM, 3112 Lastmer Road, RFD #1, Rock Creek, Ohio 44084. Will help with any general amateur problems.

Stix Borok WB2PFY, high school student, 209-25 18 Avenue, Bayside, New York 11360. Novice help.

Clyde Washburn K2SZC, 1170 Genesee Street, Building 3, Rochester, New York 14611, TV, AM, SSB, receivers, VHF converters semiconductors, test, general, product data.

Richard Tashner WB2TCC, high school student, 163-34 21 Road, Whitestone, New York 11357. General.

J. J. Marold WB2TZK, OI Division, USS Mansfield DD278, FPO San Francisco, California 96601. General.

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James Venable K4YZE MS, LLB, LLM, 119 Yancey Drive, Marietta, Georgia. AM, SSB, novice gear, VHF, semiconductors, and test equipment.

J. Bradley K6HPR/4, BSEE, 3011 Fairmont Street, Falls Church, Virginia 22042 General.

Wayne Malone W4SRR BSEE, 8624 Sylvan Drive, Melbourne, Florida 32901. General.

Bruce Creighton WA5JVL, 8704 Belfast Street, New Orleans, Louisiana 70118. Novice help and general questions.

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Louis Frenzel W5TOM, BAS, 4822 Woodmont, Houston, Texas 77045. Electronic keyers, digital electronics, IC's commercial equipment and modifications, novice problems, filters and selectivity, audio.

George Daughters WB6AIG, BS, MS, 1613 Notre Dame Drive, Mountain View, California. Semiconductors, VHF converters, test equipment, general.

Glen H. Chapin, W6GBL, 3701 Trieste Drive, Carlsbad, Calif. 92008. HF and VHF antennas, novice transmitters and receivers, VHF converters, semiconductors, receivers AM, SSB, general, surplus.

Tom O'Hara W6ORG, 10253 East Nadine Temple City, California 91780. ATV, VHF converters, semiconductors, general questions.

Steve Diamond WB6UOV, college student, Post Office Box 1684, Oakland, California 94604. Repeaters and problems regarding legality of control methods. Also TV, novice transmitters and receivers, VHF antennas and converters, receivers, semiconductors, and product data.

Orris Grefsheim WA6UYD, 1427 West Park, Lodi, California 95240. TV, HF antennas, SSB, VHF antennas and converters receivers, semiconductors, and general questions.

Hugh Wells, W6WTU, BA, MA 1411 18th Street, Manhattan Beach, Calif. 90266. AM FM receivers, mobile test equipment, surplus, amateur repeaters, general.

Carl Miller WA6ZHT, 621 St. Francis Drive, Petaluma, Calif. 94952. Double sideband.

Howard Pyle W7OE, 3434—7th Avenue, S.E., Mercer Island, Washington 98040. Novice help.

PFC Grady Sexton Jr. RA11461755, WA1GTT/DL4, Hedmstedt Spt. Detachment, APO New York 09742. Help with current military gear, information from government Technical Manuals.

Sgt. Michael Hoff WA8TLX, Box 571, 6937th Comm. Gp., APO New York 09665. Help with all types of RTTY both commercial and military. Also data techniques. Covers conversion of military RTTY equipment.

Eduardo Noguera M. HK1NL, EE. RE, Post Office Box Aereo 774, Barranquilla, Columbia, South America, Antennas, transmission lines, past experience in tropical radio communications and maintenance, HF antennas, AM, transmitters and receivers, VHF antennas, test equipment and general amateur problems. Can answer questions in Spanish or English.

D. E. Hausman, VE3BUE, 54 Walter Street, Kitchener, Ontario, Canada. Would like primarily to help Canadians get their licenses. Would be able to help with Novice transmitters and receivers.

Frank M. Dick WA9JWL, 409 Chester St., Anderson, Indiana 46012. Will answer queries on RTTY, HF antennas, VHF antennas, VHF converters, semiconductors, mobile, general, and microwave.

Gary De Palma, WA2GCV/9, P.O. Box 1205, Evanston, Ill., 60204. Help with AM, Novice transmitters and receivers, VHF converters, semiconductors, test equipment, digital techniques and all general ham questions.

Arthur J. Prutzman K3DTL, 31 Maplewood, Dallas, Pennsylvania 18612. All phases of ham radio. Can assist with procurement of parts, diagrams, etc.

William G. Welsh W6DDB, 2814 Empire Ave., Burbank, Calif. 91504. Club licensing classes and Novice problems.

Ralph J. Irace, Jr., WA1GEK, 4 Fox Ridge Lane, Avon, Conn. 06001. Help with Novice transmitters and receivers and novice theory.

Iota Tau Kappa Radio Fraternity W7YG, Multnomah College, 1022 S.W. Salmon St., Portland. Oregon 92705. This group of radio amateurs will answer any technical questions in the field of electronics.

Ted Cohen W4UMF, BS, MS, PhD. 6631 Wakefield Drive, Apt. 708, Alexandria, Va. 22307. Amateur TV, both conventional and slow scan.

Roger Taylor K9ALD, BSEE, 2811 West Williams, Champaign, Illinois 61820. Antennas, transistors, general.

Michael Burns Jr. K9KOI, 700 East Virginia Avenue, Peoria, Illinois 61603. AM, SSB, receivers, transmitters, digital techniques, novice help, general.

Jim Jindrick WA9QYC, 801 Florence Avenue, Racine, Wisconsin 53402. Novice transmitters and receivers, general.

John Perhay WAØDGW/WAØRVE, RR #4 Owatonna, Minnesota 55060. AM, SSB, novice transmitters and receivers, HF receivers, VHF converters, semiconductors, mobile, product data, general. Has access to full specifications on almost all standard components presently catalogued by American manufacturers.

Ronald King K8OEY, Box 227, APO New York, New York 09240. AM, SSB, novice transmitters and receivers, HF receivers, RTTY, TV, test equipment, general.

Charlie Marnin W8WEM, 3112 Latimer Road, RFD 1, Rock Creek, Ohio 44084. General technical questions.

Michael Winter DJ4GA/W8, MSEE, 718 Plum Street, Miamisburg, Ohio 45342. HF antennas, AM, SSB, novice gear, semiconductors.

David D. Felt, WAØEYE, television engineer, 4406 Center Street, Omaha, Nebraska 68105. Integrated circuits, transistors. SCR's, audio and rf amplifiers, test equipment, television, AM, SSB, digital techniques, product data, surplus, general.

Tom Goez KØGFM, Hq Co USAMAC, Avionics Division, APO New York, New York 09028. HF antennas, mobile, airborne communications equipment, particularly Collins and Bendix gear, AM, FM, or SSB—HF, VHF, UHF, general.

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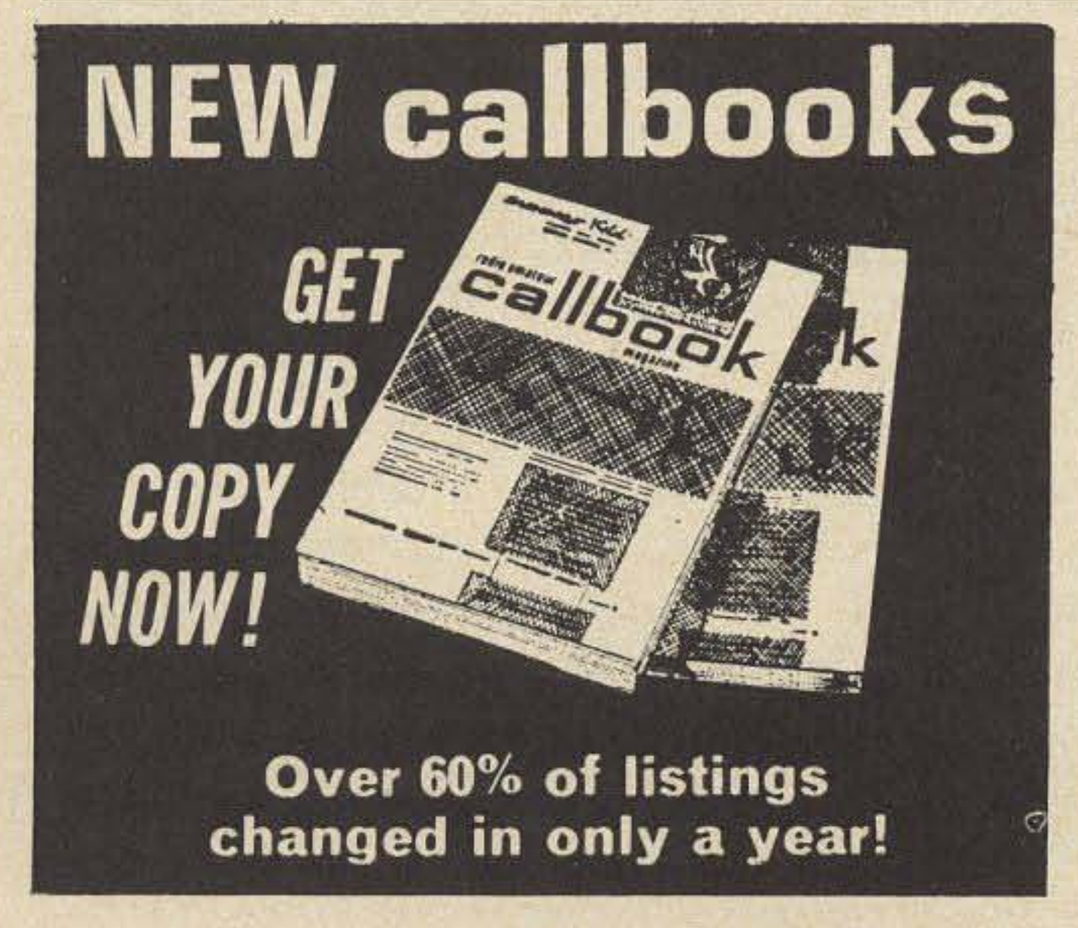

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The S.O.B.

(Sightless Operators Bridge)

Edward A. Lawrence WA5SWD/6
218 Haloid
Ridgecrest, Calif., 93555

If a sightless amateur could use a standard SWR bridge, he could make the proper adjustments to his antenna or matchbox to get maximum efficiency. But a blind operator cannot read a meter needle, so he is denied that valuable indication on any gear he may have. If the voltages are used to control an audio oscillator, they can be converted into a meaningful indication since most blind operators have very good hearing.

Here is a SWR bridge designed to indicate a null condition by the lowering in frequency of an audio tone. Only three diodes, three transistors, a UJT and a few other standard components are used. All semiconductors are silicon, for stability. Supply voltage is not critical, and the adjustments after assembly are few and easy.

Although I will describe this circuit as used in an SWR indicator, it could be used as a voltmeter with the addition of a fixed reference and appropriate multipliers.

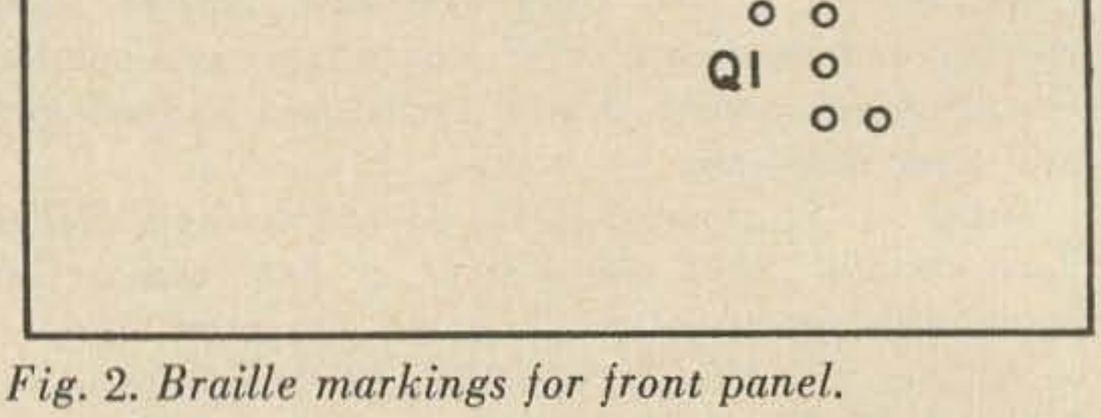

Fig. 2. Braille markings for front panel.

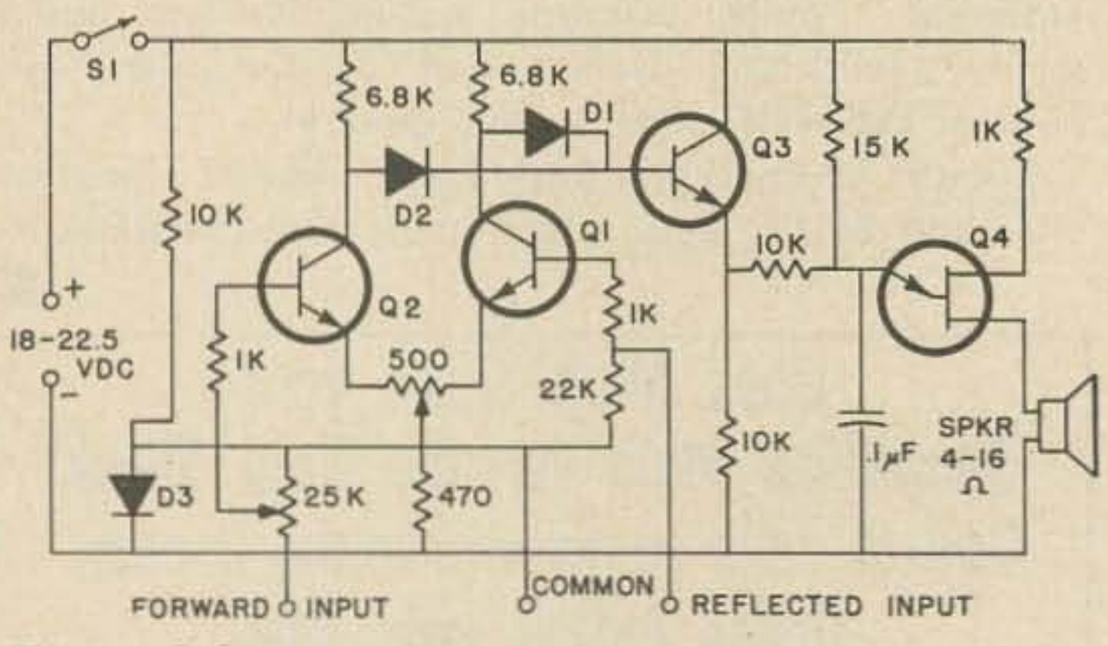

Fig. 1. Schematic diagram.

Refer to **Fig. 1**; you will see that transistors Q1 and Q2 make up a differential amplifier, which means both collectors will be at the same potential whenever the signal levels at the bases are equal. If they are not, then one collector will be higher than the other. The diodes D1 and D2 allow the base of the emitter follower Q3 to follow the higher collector. This puts the signal onto the 10 k resistor connected to the emitter of the UJT, and affects the time constant of the 15 k and the .1 μF capacitor. This varies the frequency of the UJT relaxation oscillator, which drives the speaker directly. The end result is that the audio frequency of the oscillator will rise if the signals at the inputs of the differential amplifier are not equal. Since the *reflected* voltage out of the SWR bridge is always lower than the *forward* voltage, we can find a position of the ratio pot where the amplifier is balanced. The position on the pot can be calibrated in Braille so the SWR can be read at the null position. Remember, the tone goes down at the null. Once the null is found, the tone will rise as the transmitter is peaked for maximum output.

With a good match (1.2:1 or so) a null can be detected with only three volts applied in against the reflected voltage, it would provide a sharper null with a poorer SWR. Naturally the null gets sharper with increased input. 20 vdc is about the maximum that should be applied to either input. If your SWR bridge puts out more than that, use a voltage divider to bring it down.

Note that the dc supply does not go to signal ground. This is so the signal can be

summed with the drop across D3 to prevent a 0.6 vdc dead zone. The signal voltages from the SWR bridge must be *positive* with respect to ground for this unit to work.

I said that the adjustments after assembly were few and easy. Well, one is few so here it is. Set the ratio pot to mid-range and apply a signal to top. About 6 vdc. Jumper the wiper of the ratio pot to the reflected input. This should force the bridge to balance. Measure between the collectors of Q1 and Q2. Adjust the 500 ohm pot until the meter reads zero. At this time, you should notice the audio tone dip in frequency as you reach the balanced condition. And that's all there is to it. One more check can be made at this time to insure proper operation. Short the base of Q3 to ground. This should cause the audio tone to drop to a low frequency. If it causes the tone to stop, change the 15 k resistor to a lower value.

To mark the dial in BRAILLE, use the pattern shown in **Fig. 2**. It is mirror image, so tape it to the inside of the chassis and punch through it. Use a small pointed punch and punch hard enough to raise the surface about 1/32 inch. Check to see that you can feel the pattern easily.

If possible, use a dual transistor for Q1 and Q2. It is nice but not absolutely necessary. Q4 is a 2N2160, but other UJT's will work as well. Almost any NPN Silicon transistor will work in this circuit, so don't be too fussy.

The UJT voltage controlled oscillator can also be used by itself in many applications to find a peak or dip in voltage. Some of the places that this could be applied are: Plate Current, Grid Drive, Output Power. Or the Face of the indicator could be marked to indicate Beam position if a pot were coupled to the rotor. I am sure that many more uses can be found, limited only by the ingenuity we can apply to the problems faced, which certainly isn't much of a limit.

. . . WA5SWD/6

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Getting Your Higher Class License

Part X – Basic Rules and Units

All electronics—not just amateur radio—depends upon a knowledge of a few basic rules and units. The units are voltage, current, resistance, capacitance, inductance, and reactance, and the rules let us determine how these units affect each other in any particular circuit.

Important though these units and rules are, it is possible to be a good radio operator with only a slight knowledge of them. Because of this, questions concerning these basics are at a minimum on the Advanced Class examination—and also because of this, we have saved our discussion of these until this last installment. Now it's time to take a look at them.

The questions from the FCC study list which require a knowledge of these basic principles to answer are:

15. A resistor, capacitor, and inductor each have 100 ohms of resistance or reactance. What is the equivalent series impedance of these three elements?
38. A transformer with 115 volts applied across the primary terminals has a primary-to-secondary turns ratio of 10 to 1. If a 5-ohm load is connected to the transformer secondary, the reflected p r i m a r y impedance is what? How much voltage appears across one half of the turns of the primary?
42. How do inductors combine in series and in parallel? Capacitors in series and parallel?

Following our usual practice, let's paraphrase these detailed questions into similar ones of broader scope to cover the whole range of the subject.

All three of the FCC questions deal with effects that occur only in ac circuits. We're assuming that you have some working knowledge of Ohm's Law—but this law applies only to dc circuits. For a starting question to explore, then, let's ask "How does ac differ from dc?".

One of the major differences between ac circuits and dc circuits is that in ac, we must deal with "reactance" as well as "resistance." For our question, let's determine "What is reactance?". The answers we'll find there will lead directly to another question (which takes us back to the FCC study list), "What is impedance?"

When we have a relatively clear understanding of reactance and impedance, we can move on to a question dealing directly with all three of the FCC questions: "How do impedances combine?" Finally, we'll cover all the principles involved in FCC question 38, by asking "What does a transformer do?"

Most discussions of these subjects tend to lean quite heavily on mathematics; engineering texts in particular seem invariably to rely on calculus to deal with reactance. That isn't really necessary, and we'll try to prove it by using nothing more complex than ordinary arithmetic—except for the minute amount of algebra necessary to present the various rules for calculation of results. None of them are any more complicated than Ohm's Law: E = IR.

All set? Let's get on with it.

How does ac differ from dc? The terms ac and dc are simply shorthand, as you probably know, for "alternating current" and "direct current". The major difference between these two types of electric current are that dc flows directly through the circuit, always going in the same direction, while ac changes its direction at fixed intervals, alternating between "forward" and "reverse" flow.

A flow of dc in any circuit has three

major characteristics which we use to describe it: its voltage, or the "pressure" forcing the current through the circuit; its current, the "amount" of electrical energy forced through the curcuit in a specified period of time; and its polarity, which tells the direction of flow.

These same three characteristics may be used to describe ac, but all of them have to be varied a bit when it's ac we are discussing. The voltage in an ac circuit is always changing; at one instant it may be zero, a fraction of a second later it may be 50 volts, a little later 100 volts, etc. Similarily, the current is also changing at all times from zero to some peak value and back. Finally, the polarity reverses every half-cycle; this is the key difference between ac and dc.

If we put an oscilloscope onto an ac circuit we can see directly the variations in voltage. We can also see that in any one circuit the voltage will never be more than some "peak" value. If we're looking at normal power-line ac, the voltage will swing from a negative peak through zero to a positive peak and back to zero on every cycle, and the peak values will always be the same.

We *could* use this "peak" value as our measure of voltage, and in some types of circuits we do. We could also use the full voltage swing from negative peak to positive peak as our measure—and again, some circuits *are* rated in terms of "peak to peak" voltage.

However, the normal "voltage" we talk about in an ac circuit is neither the peak nor the peak-to-peak value. Instead, we use something called "RMS" voltage which works out to be about 0.7071 times the "peak" voltage or 0.3535 times the "peak-to-peak" value. The "RMS" stands for "root mean square" and refers to the mathematical method by which the value was originally determined. For our purposes it's enough to know the ratios between RMS, peak, and peak-to-peak voltages.

The reason RMS values are used is simple: if we use this ratio for our voltage and do the same for our current, the resulting resistance values make Ohm's Law work for ac as well as for dc. If we use peak voltages, the power figures are wrong.

Another way of putting this is that the RMS values represent the *effective* dc equivalents of the ac figures. If a dc voltage of 120 volts and a dc current of ½ amp are applied to a light bulb a certain amount of light and heat are generated. If an ac voltage of 120 RMS volts is applied to that same light bulb, an RMS current of ½ amp will flow and the same amount of heat and light will result.

This takes care of *two* of our three basic characteristics—voltage and current—but the third, polarity, is a little less simple.

In an ac circuit, by definition, the polarity or direction of current flow is always changing. It would seem that we couldn't use this as a means of describing ac since any ac always involves both possible polarities.

And while it's true that we can't use it directly, we *can* use it indirectly, by using the *speed* at which it's changing. This we call "frequency"; frequency is measured in cycles per second (now known as Hertz; 1 Hz equals 1 cycle per second). One cycle is one *complete* swing of the ac from any positive peak back through zero and negative until zero is reached the third time. It's just as accurate to say a cycle is the swing from positive peak through zero to negative peak through zero back to positive peak. The important thing is that a cycle is one complete swing of the ac from any specified starting point until that starting point is reached again.

The three characteristics of ac, then, are voltage, current, and frequency. Voltage and current can be measured in either RMS, peak, or peak-to-peak values, but only the RMS values correspond directly to dc volts or amperes.

It's quite possible to have two different ac signals which have identical values of voltage, current, and frequency, but which still are not anything like "correspoonding" signals.

This comes about because both the ac signals are always changing. If both of them pass through zero, positive peak, and negative peak at exactly the same instant of time, then the two signals *do* correspond to each other just as would two dc signals of identical voltage, current, and polarity.

If, however, one of the signals passes through its *negative* peak at the same instant that the other passes through its *positive* peak, then the two are mirror images of each other even though they do both pass through zero at the same time. If we were to try to mix these two in the same

circuit, we would find that one cancelled out the other and we would have nothing left.

This is the same thing that would happen if we tried to put together two dc signals of identical voltage and current but opposite polarity; again, the two would cancel.

You can see that, with the two ac signals we're looking at, the only difference is the time relationship between the two. This time relationship between two ac signals of identical frequency is known as "phase", and is always a relative measurement. It is just as accurate to say that signal A is "ahead" of signal B as it is to say that signal B is "ahead" of signal A; the only way in which we can talk about phase is to decide that *one* signal is going to be our fixed reference point, and then say whether the other is "ahead" or "behind" that rather arbitrary reference.

Another important fact concerning this idea of phase is that it applies *only* to signals of identical frequency. If the two signals we're talking about are of different frequency, then even if they start in the same phase so that both reach positive peak at the same time, they cannot both reach the following negative peak at the same time. If they *did*, they would be of the same frequency. Being of different frequency, they take different amounts of time to go through a cycle.

The key thing to keep in mind in any discussion of phase is that the word really is a measure of *time* even though we talk about phase in terms of "degrees".

The reason that phase is measured in "degrees" is that a full cycle of ac is like a circle. Every point around the circle is a different point, and similarly every instant within the cycle of ac is a different instant. Once we have gone all the way around the circle, though, we can't tell the difference between the second trip and the two-hundredth time around—and similarly once we have examined an ac signal all the way through a single cycle, we can't tell the difference between the second and the two-hundredth succeeding cycle.

Since one full cycle is similar to one full trip around the rim of a circle, we call a cycle 360 degrees. A half-cycle then becomes 180 degrees, a quarter-cycle is 90 degrees, and so on.

For any signal of specific frequency, though, these "degrees" are actually time measurements. For instance, if our signal's frequency is 1000 cycles per second, then one full cycle takes 1/1000 second or 1000 microseconds. This makes 360° of phase equal to 1000 microseconds. A phase "lag" of 180° then equals a time delay of 500 microseconds, and a time interval of 10 microseconds equals 3.6° of phase angle.

If we double the signal frequency, to 2000 cycles per second, all the time values are cut in half but the phase degrees are not changed. Now 180° equals 250 microseconds, and 10 microseconds equals 7.2.

To sum up all of this, the major difference in description between ac and dc are that dc is measured in constant volts, constant current, and constant polarity, while ac is measured in terms of varying voltage, varying current, changing polarity at a known frequency of change, and, if two or more signals of identical frequency are involved, relative phase.

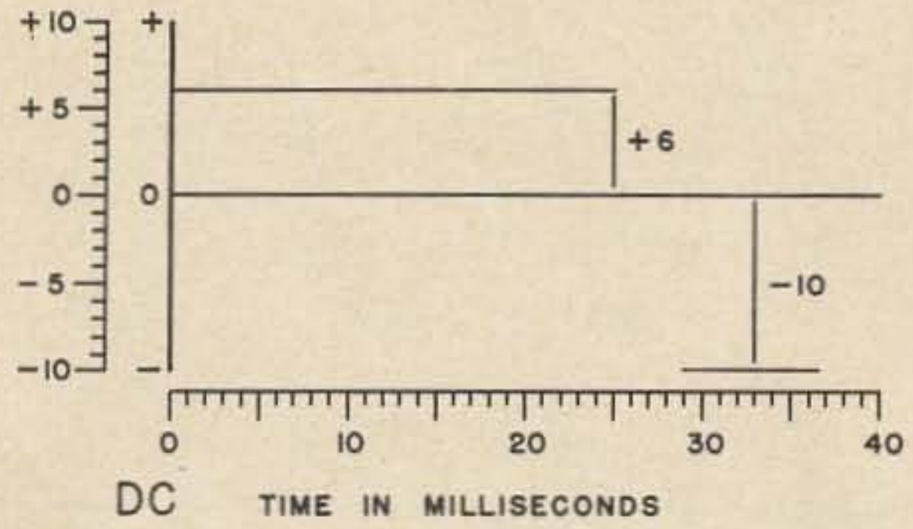
When the idea of phase can be applied —which is only when frequency is not changing—it corresponds more directly to dc's "polarity" than does frequency. For example, two dc signals of equal voltage and current but opposite polarity will cancel each other out. So will two ac signals of equal voltage, current, and frequency, but 180° out of phase with each other.

What is reactance? Now that we have the necessary words and ideas, we can take a look at this thing known as "reactance" which is found only in ac operation; there is no dc equivalent.

So far we have talked about relative phase between two ac signals, with the unspoken assumption that we were talking about two distinct signals—maybe even on different wires—each of which had its own voltage and current values.

Actually, in the world of ac, voltage and current don't necessarily bear the fixed relationship to each other that they do when it's dc we're involved with. In a single ac circuit, with only one "signal" in the usual sense of the word, we have to think of the *voltage* as one signal and the *current* of that same circuit as another, separate signal.

When the "two" signals we're examining are actually the voltage and current in a single circuit, then they must be of the same frequency, and the idea of "phase" is applicable.



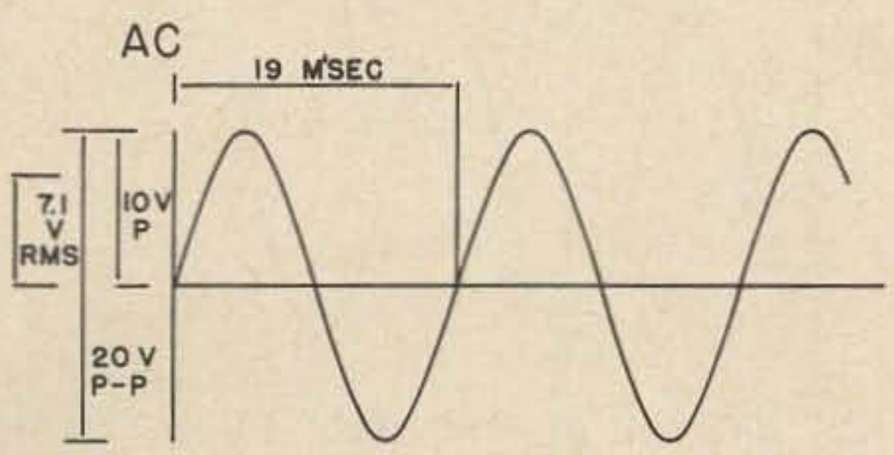


Fig. 1. Differences between dc and ac are shown by these illustrations which represent either current or voltage in a circuit. dc (A) is steady in the same direction, while ac (B) reverses direction at fixed frequency.

And like the two separate signals we examined a few paragraphs back, they can have any conceivable time relationship with each other.

For a start, let's assume that the two signals voltage and current are in perfect step with each other. The phase difference is 0°; when voltage is zero, so is current. When voltage is at positive peak, so is current. This is the "normal" case for an ac signal, and most descriptions of ac are based on this assumption.

However, it's possible for voltage and current to be out of phase. If they are out of phase with each other by 90 degrees, then when one is going through a peak value the other is zero. For example, if the current is 90° *ahead* of the voltage, then when voltage is at its positive peak value the current is zero. As voltage descends toward zero, the current value will be going towards its negative peak. When voltage reaches zero going negative, current is at the negative peak, and as voltage gets more negative the current is becoming less negative. When voltages reaches the negative peak, the current has again become zero going positive.

Now *power* in a dc circuit is simply the product of voltage times current, and in an ac circuit if both voltage and current are in phase is the product of RMS voltage times RMS current.

But when voltage and current are out of phase, the *power* available is *less* then the product of RMS voltage and RMS current. Staying with our current-ahead-by-90° example, when voltage is peak current is zero and power must also be zero. When current is peak; voltage is zero and power is still zero. During most of the cycle, current is peak; voltage is zero, and power is still zero. During most of the cycle, current is going one way and voltage is going the other, and again they tend to cancel out. The *only* time that any power is available in this situation is during that fraction of the cycle that voltage and current are both going the same way, and even then since both are far below their peak values the power is far less than would be expected.

If we shift things around so that voltage and current are a full 180° out of phase, then no power at all is available in the circuit although both voltage alone and current alone may be extremely large values.

This has the same effect as does *resistance* so far as available power in the circuit is concerned, but there's a major difference.

Resistance in a circuit converts the electrical energy into heat energy. Once that's done, the electrical energy is gone and we can't get it back.

The effect we're examining doesn't involve such a change. Instead, it merely changes the time relationship between voltage and current so that the energy is no longer available for use. If we should do something to change the time relationship back again, the energy would still be there for us to employ.

Because the effect is so similar to that of resistance, we measure it in the same electrical unit—ohms. Because it is *not* the same effect, we give it a different name, and this name is "reactance".

To put it simply, then, reactance, is just the measure of how much the time relationship between the voltage and current in a single ac circuit has been changed.

Since we can, if we use the *current* as the reference signal and consider the *voltage* as the signal which changes in time, move the voltage either ahead of or behind the current, the reactance can be either positive or negative. A negative reactance value means that the voltage has been delayed with respect to the current, so that the volt-

age is *behind* the current. A positive value of reactance means that the current has been delayed, so that the voltage is *ahead* of the current.

Two types of circuit elements have reactance, and the two have reactances of opposite types. The circuit elements are capacitors and inductors. The capacitor has negative reactance—which means merely that putting a capacitor in an ac circuit will cause the voltage to lag behind the current in that circuit. The inductor or coil has positive reactance; it causes the current to lag behind the voltage.

Frequently you'll meet the terms "capacitive reactance" and "inductive reactance." This just means that the net effect looks like either a capacitor or a coil, regardless of what is actually in the circuit.

Before we get away from this, let's take a small side trip and see why capacitors and coils have these effects.

First let's look at an empty or discharged capacitor and connect dc to it. At the instant of connection a large current will flow into the capacitor, charging it. As the capacitor charges it gains voltage of its own, and this voltage "bucks" the applied charging voltage. The current flow is determined by the effective charging voltage, and this effective voltage is equal to the actual voltage of the source minus the voltage on the capacitor.

The result is that as the capacitor changes, the charging current gets less and less. When the capacitor is fully charged, no current flows.

Now let's try that same thing with ac instead of dc for a source. Let's also assume that the ac is of fairly low frequency and the capacitor is of only moderate capacitance. Under these conditions the capacitor will have time to become fully charged before the ac reverses its polarity.

When the ac is applied, a large charge current starts to flow. As the capacitor's voltage bucks the applied voltage and current flow drops off, the applied ac voltage continues to change.

By the time the ac voltage reaches its peak value the capacitor has become fully charged and the current value is zero. So far the only difference between this and the action on dc is that with ac, the applied voltage was not steady but was always increasing.

When the ac voltage reaches its peak it begins to drop back toward zero. Now the

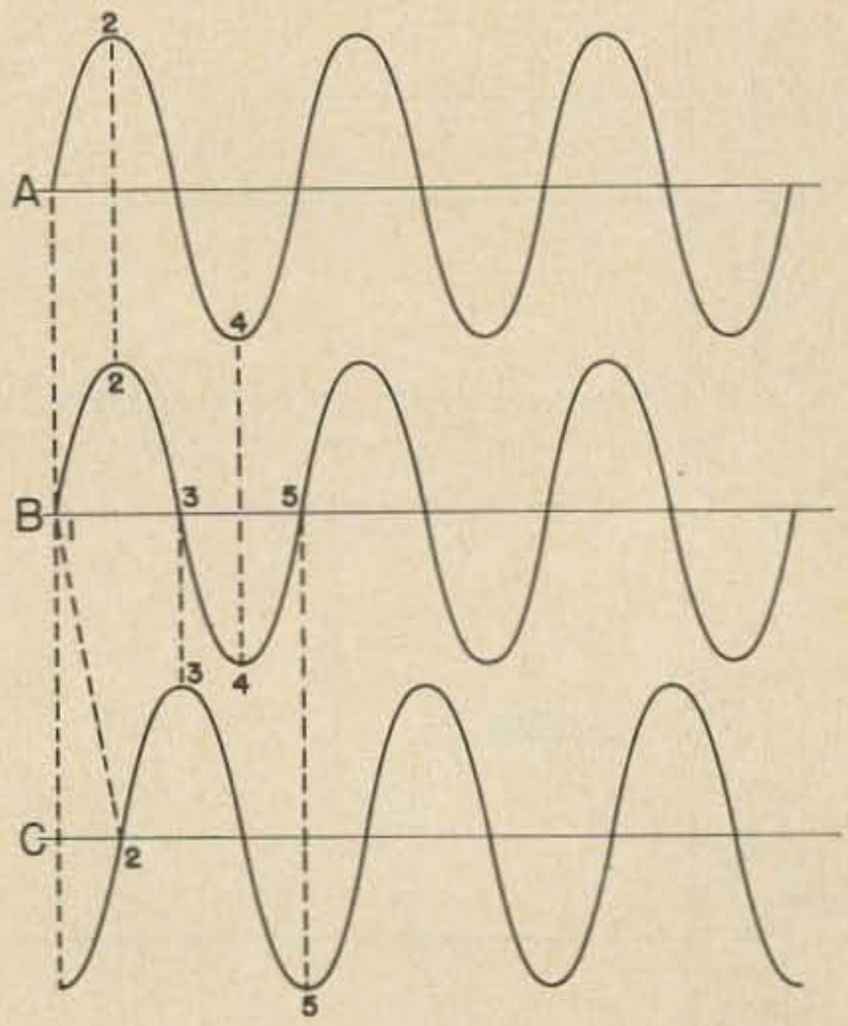


Fig. 2. "Phase" applies only to ac signals of identical frequency, and is a measure of their timing relative to one another. Here, for instance, signals A and B have 0° phase difference since they reach their peaks and cross zero at the same times. Signal C, however, is out of phase with either A or B since it peaks as they cross zero, and crosses zero when they peak.

capacitor is charged to a higher voltage than the applied voltage and it must begin discharging. It dumps out some charge, which becomes a current in the opposite direction.

As the ac voltage keeps dropping, the difference between the capacitor's voltage and the applied ac voltage gets larger and larger, so the current flow keeps getting larger and larger also in the reverse direction. When the ac applied voltage reaches zero, the discharge current is very high.

But as soon as the ac applied voltage goes through zero it changes direction, and now it's going the same way as the discharge current. This means that the applied voltage is now catching up with the discharge action and the voltage difference is getting smaller rather than larger. This in turn reduces the discharge current flow, so that the peak value of current occurs at the time voltage passes through zero.

As voltage moves toward the negative peak, the current flow continually decreases, and when voltage is at negative peak the capacitor's charge voltage and the applied voltage balance each other exactly. The resulting current flow is zero.

ac voltage then begins decreasing back toward zero, going now in the positive di-

rection. The capacitor is still charged to negative peak, so that the difference between applied voltage and charge voltage results in current flow into the capacitor in the positive direction again.

This process continues indefinitely; the current is always a quarter-cycle, or 90 degrees, ahead of the applied voltage. By definition, the reactance value when current leads voltage is negative.

If the capacitor is made larger, then it may not have enough time to become completely charged or discharged during any half-cycle of the ac signal. The current will still lead the voltage, but not necessariy by the full 90 degrees. If there is not enough time to fully charge the capacitor before the voltage polarity reverses, then the phase shift introduced by the capacitor will be less than 90 degrees. As we said earlier, reactance is a measure of how much the phase has been shifted—so that for signals of the same frequency a large capacitor has *less* reactance than a small one.

Since all this depends upon *time*, we can keep the capacitor size the same and change the signal's frequency to achieve the same result. If the frequency is increased then each cycle occupies less time, and again the reactance will be smaller.

Thus the reactance of any capacitor depends upon just two factors—the size of the capacitor and the frequency of the applied ac. If either of these factors goes up, the reactance goes down.

To calculate reactance for a capacitor, plug the two factors into the capacitive-reactance formula:

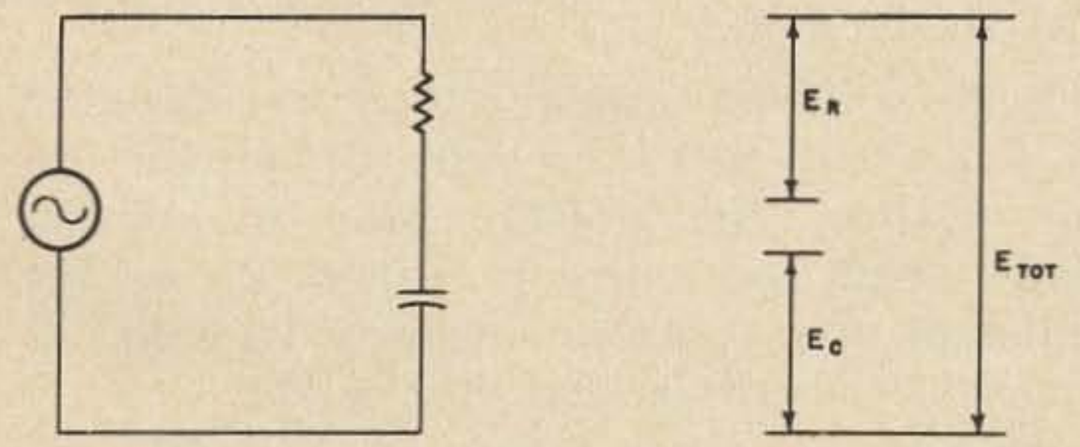


Fig. 3. This circuit illustrates differences between resistance and reactance in ac circuits. If resistance of resistor and reatance of capacitor are equal, voltages Er and Ec will be equal, but total supply voltage Etot will not be equal to the sum of the two. Instead, it will be less. See text and Fig. 4 for details of how this can be possible.

$$X_C = 1/6.28fC$$

In this formula, X_C stands for capacitive reactance, f is for frequency, and C is for capacitance. When the frequency is in cycles per second and the capacitance is in *farads*, the reactance comes out in ohms. However, farads are much too large a unit for practical capacitance values and we use microfarads instead. This changes the formula a little bit:

$$X_C = 159000/fC$$

The 159000 is a conversion constant which picks up the 6.28 of the earlier formula and also includes the million-to-one difference between farads and microfarads. In this formula, f is still in cycles per second but C is in microfarads. X_C is reactance in ohms.

When a coil is involved instead of a capacitor, the actions are similar but opposite.

When the applied ac voltage is zero nothing happens. As the voltage climbs toward its positive peak, current attempts to follow —but instead it is diverted by the coil into the *magnetic* field around the coil. So long as the voltage is climbing the current goes into the magnetic field instead of through the coil.

When the voltage stops climbing, at the positive peak, the magnetic field has its maximum energy. As the voltage starts to drop, it's not large enough to sustain the magnetic field at full energy and the stored current begins to be returned to the circuit. However, the voltage is dropping more rapidly than the energy can be released, and until the voltage drops to zero the current flow is continually increasing.

As the voltage passes through zero and starts going the opposite direction, a new current-storage effect begins to oppose the release of energy. The result is that current peaks at a voltage level of zero.

As the voltage moves from zero to its negative peak, the new current-storage effect and the previous current-release effect battle each other. The amount of current released continues getting smaller and smaller, and when the voltage reaches negative peak the two current effects finally cancel each other out to make net current flow zero.

Now as the voltage again climbs from its negative peak going positive, the effects re-

peat themselves with opposite polarity. The long-range effect is that the current lags behind the voltage—the opposite of the effect produced by a capacitor

As in a capacitor, the effect depends upon both the size of the coil (which determines the total amount of energy which it can store) and the frequency of the ac (which determines the time available for storage.) However, *inductive* reactance as in a coil goes up if either the coil size or the frequency goes up, while capacitive reactance went down.

To calculate inductive reactance, knowing the frequency of the ac signal and the inductance of the coil, use this formula:

$$X1 = 6.28fL$$

In this formula, f is in cycles per second (Hz) and L is in henries; X1 is in ohms. The formula is suitable in this form for power and audio frequencies. *rf* inductors are usually measured in microhenries; rather than changing the formula, simply use megacycles rather than cycles for frequency to use microhenries instead of henries for inductance, and X1 will still come out in ohms.

What is impedance? We have seen now how ac and dc differ, and we have defined "reactance" as a measure of the amount and direction by which the phase of the voltage in an ac circuit is shifted relative to the current in that same circuit.

Like resistances, reactances are measured in ohms, because like a resistance, a reactance reduces the amount of power available for use in the circuit. The major difference is that the resistance gets rid of the power completely by changing it to heat, while the reactance merely locks it up by changing time relationships.

Even though both are measured in ohms, reactance and resistance don't combine as directly as you might imagine. It's perfectly possible to have both in a circuit; in fact, it's impossible *not* to have both in any practical circuit. When both are present, the circuit behaves differently than it would with either alone. But it behaves in a manner which may at first appear a trifle strange.

Keep in mind that a resistance follows Ohm's Law for both dc and ac, provided only that ac voltage and current values are expressed in RMS terms. A reactance, on the other hand, appears on the surface to follow Ohm's Law—but its limitation of current (or voltage) is due to a time shift which it introduces.

Now take a look at the series circuit in **Fig. 3**, which contains both a resistor and a capacitor. We know that the capacitor has capacitive reactance; we'll assume that the frequency of the ac we're using and the size of the capacitor are such that this capacitive reactance is exactly equal to the resistance of the resistor.

Since both the resistor and capacitor are in series, all the current which goes through one must go through the other.

Going through the resistor, this current will produce a voltage drop determined by Ohm's Law, equal to the RMS current times the resistor value in ohms.

Going through the capacitor, this current determined by Ohm's Law—equal to the RMS current times the capacitive reactance in ohms.

This means that in this circuit, we have two separate voltage drops in series. It apparently stands to reason that each of them must account for half the total applied voltage; that is, if we put 115-VAC line power across the circuit we would expect to measure about 57.5 volts across each.

But that's not what happens. Instead, we'll measure about 81.6 volts across either the capacitor or the resistor.

So how can 81.6 volts in series with another 81.6 volts equal only 115 volts? The answer is, it all depends upon the timing.

These are ac voltages, remember, and an ac voltage is always changing from one peak value through zero to another peak. The only way 2+2 can equal 4 when it's ac voltages we're adding is if both voltages are "2" at the same time—and in this circuit, they're not.

Both voltages, you'll remember, resulted from current flow through the circuit. In the resistor, the voltage was exactly in phase with the current. However, in the capacitor, the voltage waveform lags 90° or one-quarter cycle *behind* the current.

That means that when Er, the voltage across the resistor, is at its positive peak, then Ex, the voltage across the capacitor, is only at zero, climbing toward positive. A quarter-cycle later, Er has reached zero on the downhill path and Ex has gotten to positive peak. The two are never in step with each other.

When both are going in the same direction, they add to and reinforce each other. When they're going in opposite directions, they tend to cancel out and only the larger survives in the total circuit. Fig. 4 shows this action by means of the waveforms of Er, Ex, and the resulting total-circuit voltage waveform.

The total voltage is the sum of the two individual voltages, and as you can see it is larger than either alone—but not twice as large.

In fact, with sine-wave voltages (which are the only kind we're talking about) the sum will be 1,414 times as large as either voltage alone, which makes the voltage across either element alone equal 0.707 times the total applied voltage, rather than half the total as we would expect.

We'll get back to this a little later, since it's the basis of one of the most important principles in radio. For now, let's continue down the road to find out "What is impedance?"

Take another look at **Fig. 4**, and this time notice the effect upon the timing of the various waveforms. The capacitive reactance shifted phase of the voltage a full 90° from that of the current while the resistor's phase shift was 0°. When the two voltages added together, the final phase shift was reduced to 45°.

When resistance and reactance are both present in a circuit, the phase shift is always less than 90°. Just how much less depends upon the ratio of resistance and reactance; in our example the two were equal so the phase shift was cut in half.

This combination of reactance and resistance in the same circuit is what's known as "impedance". Actually, "impedance" is the only thing you *can* have in an actual circuit. Pure resistance, like pure reactance, exists only in theory. Any resistor must have leads; the leads have at least a little inductance. This inductance puts a trace of inductive reactance into the circuit. Similarly, the insulation of a capacitor is never perfect; there's always at least some trace of leakage resistance through the insulation.

And even in theory, both pure resistance and pure reactance are merely special forms of the general idea "impedance". The best way to illustrate this is to look at the way engineers write down impedances.

Two ways are used; both have mathematic foundations but the math isn't important to us.

One way, based on the way a complex number is written, is to specify the impedance as the sum of pure resistance and pure reactance. If we represent the ohms of resistance by "A" and the ohms of reactance by "B", then the impedance becomes:

$$A + jB \text{ ohms.}$$

The "j" is from mathematics and indicates that the "B" is a reactance with 90° phase shift. The "jB" term may be either positive or negative depending upon the type of reactance involved.

The other way is to write the absolute impedance value and phase shift:

$$Z/\theta^{\circ} \text{ ohms.}$$

To use this way, "Z" must be calculated and so must θ; we'll stick with the "A + jB" method the rest of the way.

Now if we want to talk about a theoretically pure resistance, we can still describe it as an impedance of "A" ohms resistance and *zero* ohms of reactance, by writing "A + j0" as the impedance value.

Similarly, if we want to describe a pure reactance, it can be written "0 ±jB" ohms to indicate *zero* ohms of resistance but "B" ohms of reactance, with the + sign indicating that it's inductive or the − sign indicating capacitive.

Any time that neither A nor B is zero, you know that both resistance and reactance are present—and you're dealing with an impedance.

How do impedances combine? The reason we've gone into such detail about the "A" and "jB" method of describing impedances is that it makes all questions of combined impedances simple.

To calculate the impedance of a series circuit made up of several impedances (any of which may be "pure" resistances or reactances), all we have to do is total up the "A" values of each separately, do the same for the "jB" values, and write down the result.

Negative reactances cancel out corresponding amounts of positive reactance and vice versa.

For example, let's attack that study-list question about the 100-ohm resistor, capacitor, and inductor. First, let's describe the impedance of each of these elements sep-

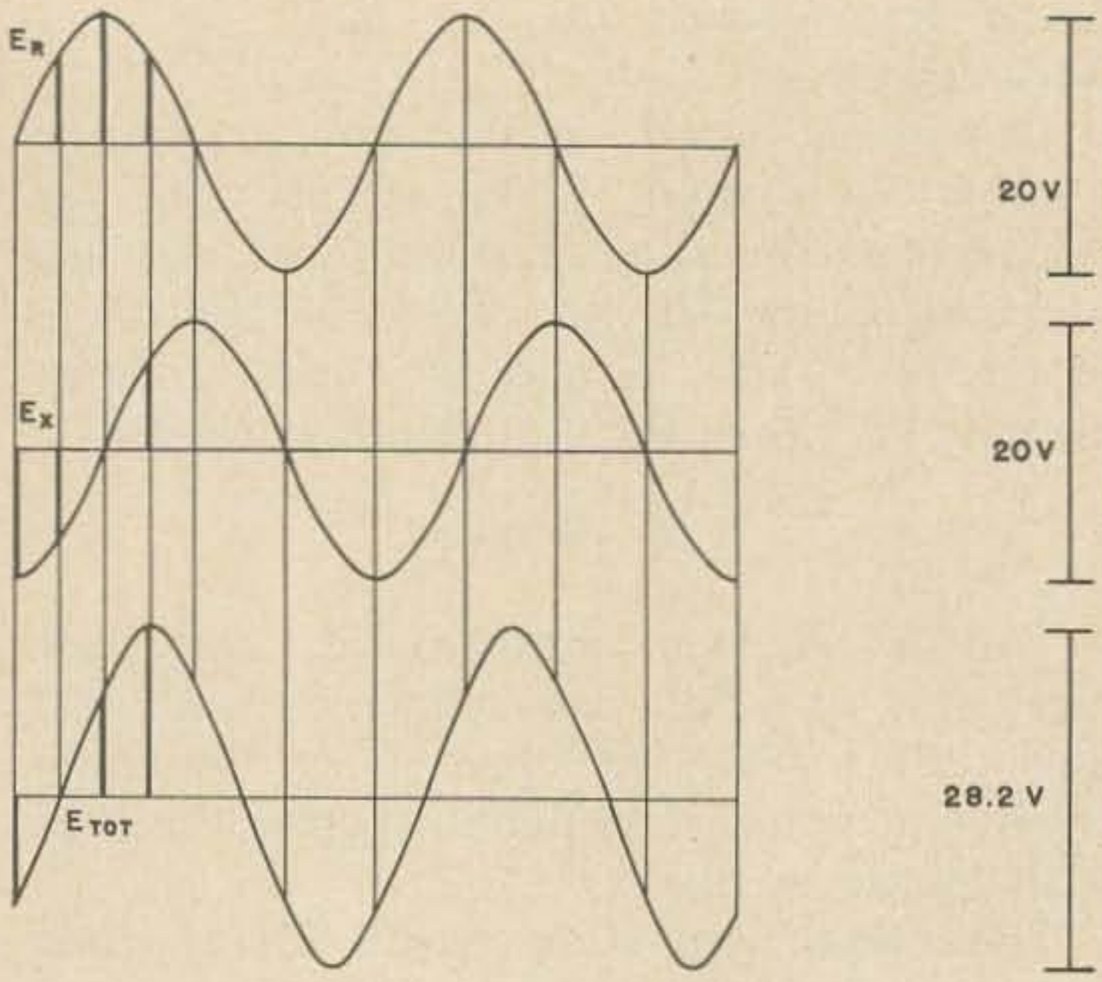


Fig. 4. Waveforms show timing differences between voltages across resistor and capacitor in circuit of Fig. 3. Total voltage always equals the sum of the instantaneous voltage values as indicated by the vertical matching lines. With 90° phase shift, peak of total is 1.41 times that of either part.

arately. The resistor would be 100 ± j0 ohms since it theoretically has no reactance. The capacitor would be 0 - j100 ohms since it's all reactance, and capacitive. And the inductor would be 0 — j100 ohms since it too is all reactance, but positive.

The total series impedance is then (100 + 0 +0) for the "A" side, plus (0 — 100 +100) or (0) for the "B" side, and we find quite directly that the effective circuit impedance is only 100 ohms resistive —or 100 ± j0 ohms.

So far as the effective impedance of the circuit is concerned, the capacitor and the inductor have cancelled each other out!

They're still there, though, and the current flowing through this series circuit must flow through each of the elements. The capacitor and the inductor won't have any effect upon the total current, so the only factor limiting current from the power source will be the 100-ohm resistance.

To keep the figures simple, lets assume that we have a 100-volt generator feeding a circuit like this. That makes the RMS current through the resistor 1 amp.

But that 1 ampere flows through the coil and the capacitor also, not through just the resistor, and it causes 100 volts to appear across the capacitor and another 100 volts across the inductor. These are voltages which can be measured with an ordinary VTVM.

What the meter won't show is that the voltage across the capacitor is 90° behind the current, and that across the inductor is 90° ahead. This totals up to a pair of voltages 180° out of phase with each other, and they cancel out so far as the external circuit is concerned.

With the values given in the FCC study question this may not seem like much—but let's try some different values and see how things shape up. Let's trim the resistance back to 1 ohm and leave the inductor and the capacitor at 100 ohms each. While we're at it, lets cut the voltage down to 100 volts RMS.

Our impedances now are 1 ± j0 ohms for the resistor, 0-j100 ohms for the capacitor, and 0±j100 ohms for the inductor. The total circuit impedance, then, is (1+0+0) ± j(0—100+100), or 1 ± j0 ohms. With 10 volts RMS applied, the current will be 10 amps RMS.

Note that the two reactances, being equal, have cancelled each other out just as before. But now we have 10 amps flowing through the circuit, so that the voltage developed across the capacitor will be 10 times 100 or 1000 volts RMS, 90° behind the current, and that across the inductor will also be 1000 volts RMS but 90° ahead of the current.

From the standpoint of the 10-volt power source, neither of these kilovolt levels exists. However, if we tap off just the voltage across either the coil or the capacitor—just the same way we would measure it with a meter—and feed it into an amplifier, we will actually get this 100-to-1 voltage step-up.

What's more, since reactance depends upon frequency, there's only one frequency at which any coil-capacitor pair has identical reactance. This frequency is known as the "resonant" frequency of the combination, and is the basis for all our tuned cirtuits.

We've already seen that any actual circuit must have both resistance and reactance; this means that we can never quite reach the ideal theoretical conditions we've been examining here. Reactive elements such as coils or capacitors, as well as combinations of these elements such as tuned cir-

cuits, are supposed to approach this ideal as closely as possible. They are rated by a "quality factor" usually known simply as "Q", which is the ratio of "energy stored" to "energy released" or more plainly, the ratio of *reactance* to *resistance* in the circuit.

For example, the FCC question uses values of 100 ohms for both resistance and reactance; the Q of this circuit is 100/100, or 1. Our modified version, though, had 100 ohms reactance and only one ohm resistance, for a ratio of 100/1 or a Q of 100.

The higher the Q of a reactive element, the more energy it will store. This is not always an advantage. Transmitter tank circuits, for example, must operate at relatively low Q in order to let the power be released to the antenna.

The same combination-of-impedances approach we have been examining throughout this section can be applied to the combining of similar impedances.

The key factor to remember is that impedances in series *add* their A and B values to each other, but impedances in parallel split the effects of their A and B values just as do resistors. The total resistance of R1, R2, and R3 in series is (R1 + R2 + R3), but if the three are connected in parallel the effective value becomes 1/((1/R1) + (1/R2) + (1/R3))

Similarly, three impedances A1+jB1, A2+jB2, and A3+jB3 in series have a total impedance of (A1 + A2 + A3) + j(B1 + B2 + B3). In parallel, the picture becomes a bit more complicated since the value of 1/(A+jB) isn't so easy to figure directly. It comes out to be (A-jB)/(A^2 +B^2), and when you start adding up a string of these, things get messy in a hurry.

It's actually easier to handle this kind of problem by ignoring "impedance" for a moment and going back to the values of inductance or capacitance involved.

When inductors are connected in series, their effects add up just as do those of resistors. In parallel, the effects are split just as are those of resistors. These statements are true *only* if the various inductors involved are not coupled to each other in any way; if they are, some transformer action gets into the picture and modifies the effects in an unpredictable manner.

Capacitors, on the other hand, behave oppositely—which we might expect since in all other respects they act as opposites to inductors. When capacitors are connected in parallel, their effects add up; in series, the effects are split.

To determine the impedance of a string of parallel-connected inductors or series-connected capacitors, then, you can simply figure up the effective inductance or capacitance by the parallel-resistor rule. Then plug this single value into the reactance formula to determine the effective reactance of the group.

What does a transformer do? The theory behind transformers usually is made to appear extremely complex, and it isn't helped a bit by the fact that we use these devices for both power transformation and signal transfer—with different theory for each application.

When we're talking about power transformers, we usually talk about voltage or current step-up or step-down, and sometimes about turns ratio.

When, on the other hand, we're talking about signal transformers, we almost invariably talk about "impedance matching".

Actually, the theoretical differences between a power transformer and a signal transformer are almost non-existent. What differences exist are detailed ones, concerning the frequency range, power loss in the wires, and the like.

The basic transformer itself could care less which job it's doing, because it does both in exactly the same way—by transforming *impedance*.

To see how this works, let's get used to thinking of power in "impedance" terms by looking at resistors instead. If you take a 120-ohm resistor and connect it to a 12-volt auto battery, it will permit the 12/120 ampere, or 1/10 amp, to flow. This 1/10 amp times 12 volts amounts to 1.2 watts. A 2-watt resistor could be used, but it would get rather warm.

If we use a 12-ohm resistor instead of 120 ohms, then 12/12 ampere—or 1 amp—of current will flow, and we will have 1 x 12 or 12 watts of power in the resistor.

The point is that the voltage did not change—but by changing the resistance, we changed the amount of current taken from the battery and thus changed the amount of power we were using.

The point is that the voltage did not change—but by changing the resistance, we

changed the amount of current taken from the battery and thus changed the amount of power we were using.

Now a resistor is a special kind of impedance. Our first resistor had an impedance of 120 + j0 ohms, and the second had an impedance of 12+j0 ohms. Had we been using ac rather than dc the results would have been the same—reducing the impedance to 1/10 its original level while keeping voltage constant would have permitted 10 times the current to flow, or 10 times the power.

Had we left the resistor's value constant, but instead changed from a 12-volt battery to a 120-volt power supply to provide a 10-time increase in voltage, the power would have gone up by 100 even though impedance remained constant.

This happens because the current goes up right along with the voltage; while only 1/10 amp would flow at 12 volts for 1.2 watts, at 120 volts a full amp would flow. This is 10 times the voltage and another 10 times the current; the power increase is 10 x 10, or 100 times, for 120 watts.

Now a transformer consists, in its most basic form, of two coils which share the same magnetic core. When current flows through one of these two coils, it is accompanied by a magnetic field. The strength of the field depends both upon the strength of the current and upon the number of turns in the coil. This magnetic field (so long as it is changing) induces a corresponding current to flow in the second coil, and this induced current again depends upon the strength of the magnetic field and upon the number of turns in the coil.

Both coils, being coils, have inductance. Hence they have inductive reactance—and are both impedances, since the wire of which they are wound also has some resistance.

A well-designed transformer has little reactance or resistance of its own, but any *other* impedances in the circuit will reflect back to the transformer because they will affect current flow in the circuit. This will, in turn, affect current flow in one winding or the other of the transformer, and that it will influence the strength of the magnetic field which provides the transformer's main action.

One other factor, which we have already mentioned, also influences the transformer's action—the number of turns upon each coil. As it happens, the strength of the induced current (assuming that the strength of the magnetic field doesn't vary except as determined by the ac frequency) depends directly upon the number of turns in the coil. If a coil of 10 turns provides an induced current of 1 amp, then a 20-turn coil will provide twice as much or 2 amp. Similarly, the strength of the magnetic field depends directly upon the number of turns: if a 10-turn coil will induce a magnetic field of 1000 gauss (the unit of magnetic field strength), then a 20-turn coil carrying the same current will induce a 2000-gauss field.

The two windings in a transformer are called the "primary" and the "secondary". The primary is the winding carrying the original current which produces the magnetic field; the secondary is the winding in which the induced current produced by the field flows. Transformers may have many secondaries; most, though, have only one primary.

Since the number of turns on the primary determines the magnetic field strength with a given primary current, and the number on the secondary determines the induced current with a given magnetic field strength, the *ratio* "primary turns"/"secondary turns" gives us a direct indication of the current ratio to expect. The effects of the magnetic field, although indispensable to transformer operation, disappear from the scene so far as we are concerned.

Now let's back up a moment and look again at our resistor with varying voltages on it. When we boosted the voltage by 10 times, with fixed resistance, the current went up by 10 also.

Had we had any method of increasing current by 10 times, we would have found that the voltage went up accordingly. In either event, the power would have gone up by 100 times when either the voltage or the current was changed by a factor of 10, so long as the impedance (resistance) remained constant.

If we increased the current by 10 times but found it necessary to keep the *power* constant, the only way to do it would be to *decrease* the impedance by a factor of 100. Ten times the current, flowing through 1/100 the impedance, would result in 10/100 or 1/10 the voltage—and 1/10 the voltage

times 10 times the current would make the power come out at 1.

When we put a transformer with a 10-to-1 primary-to-secondary turns ratio into a circuit, the secondary current is 10 times as great as that in the primary as we saw before. But the transformer is *not* a power source; it cannot put any new power into the circuit. The total power, then, must remain constant. This means that the secondary voltage must be only 1/10 as great as that across the primary—and that the secondary impedance can be only 1/100 of that at the primary.

This is a general rule for all transformers; they transform *impedances*, and the impedance transformation is equal to the *square* of the turns ratio. When the impedance is changed, both voltage and current are also affected, and the transformation of *either* voltage or current is equal to the turns ratio alone (not squared).

A 10-to-1 transformer connected across a 115-volt AC power line, then, will produce an output voltage of 11.5 volts across its secondary. A 5-ohm load connected to the secondary will be reflected as 100 times 5 ohms, or 500 ohms, at the primary, and there it will draw 115/500 or 0.23 amps. The current set-up in this transformer is also 10 to 1, so 2.3 amps will flow in the secondary circuit. To check all this, 2.3 amps through 5 ohms should equal 11.5 volts—and it does.

If the primary is center-tapped, the turns ratio from half the primary to the secondary is only 5 to 1, so the impedance across either half of the primary is only 125 ohms rather than the 250-ohms you might expect. This is a fact about transformers which many persons find puzzling. So long as you think in terms of voltage and current, though, as we did in that previous paragraph, you'll come out okay. Across half the primary, we have half the 115-volt supply or 52.5 volts. We have, however, twice the normal primary current. This is because we have flowing in this winding the full primary current of 0.23 amps, and *also* an induced current of another 0.23 amps because of the current flow in the other half of the primary. With 0.46 amps and 52.5 volts, we find 52.5/0.46 or 125 ohms impedance.

Incidentally, realization of the fact that any transformer is an impedance-changing device makes it easy to find uses for iron in the junk box. Those surplus 400-cycle power transformers, for instance, come in very handy as modulation transformers. You can either calculate or measure the turns ratio by comparing primary and secondary voltages, and obtain the impedance transformation ratio by squaring the turns ratio. Many center-tapped high-voltage transformers work out nicely as push-pull audio transformers, for medium-power AM rigs.

In the case of a signal transformer, signals are applied to the primary. Their voltage and current are both changed by the turns ratio, and the transformed signals come out at the secondary to meet some "load" impedance. That load impedance, in turn, determines the actual amount of current which flows in the secondary circuit. No more current can be present than that determined by the load, and this is reflected back into the primary circuit. Thus our 10-to-1 transformer makes a 5-ohm load look like 500 ohms to the primary circuit. A transformer with a 30-to-1 turns ratio would make 5 ohms in its secondary look like 5 x 900 or 4500 ohms in the primary. Vacuum tubes require high-impedance loads, while most antenna or audio circuits operate at low impedance—so transformers are necessary in almost all stages.

Next Month. This winds up the Advanced-Class study course; about all that we haven't covered in it are the FCC regulations themselves, and there's no substitute there for reading the actual regulations. The key things to remember from them for the test are the frequency limits of the various bands, including the CW, phone, etc., sub-bands, the legal record requirements on logs, identification, and the like, and required operating procedures.

However, the response to this course has been so great that we're not stopping now. Quite a few of you, we suspect, will be interested in going beyond Advanced Class to the Extra Class ticket—so next month we'll dive into the Extra Class questions, with the same type of approach we've been using all year. Until then, good luck—and happy studying. ■

This completes the Advanced License course. The ten chapters in this course will soon be available in book form. ed.

Care and Feeding of a Ham Club

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Part VII — Operation Public Service

Unlike basket weaving and chess, amateur radio is a hobby that not only entertains and educates but comes through during disasters to provide emergency communication. When ice storms, fires, floods, tornadoes, and hurricanes strike, radio clubs are called on to go to bat, and members should know how to use their stations at such times. And there definitely is "know-how" involved. It's o.k. to give handle and QTH and drag out a signal report during a leisurely rag-chew, but when power lines are down and messages pile up, snappy, down-to-business procedures should be used to get the most said in the shortest time.

Although most hams realize the need to be prepared for emergency conditions, there may be a spat at a club meeting about how much time should be devoted to planning and drilling. If the members vote unanimously to participate in the AREC/RACES program (Amateur Radio Emergency Corps and Radio Amateur Civil Emergency Service), drills can be planned frequently. But should some members feel the club is meant to be "all-fun and no-work," then training will have to be sandwiched in with other activities or perhaps scheduled for a different evening.

Many clubs have worked hard to convert buses and panel trucks into complete stations with transmitters on all bands, several operating positions, and even coffee bars. Any member of the Western Illinois Radio Club at Quincy will vouch for the value of a well-equipped bus after the April '60 flooding of the Mississippi.

Faced with a shortage of men to sandbag, the hams patrolled the levees with hand-carried transceivers and called workers to weak spots. The entire operation was coordinated by the local hams working through the privately-owned and equipped emergency bus operated by Ken Morrisson, WØTBI, of Hannibal, Missouri, just across the river. Your club may not be able to buy a bus, but purchasing a generator for emergency power should definitely be a goal.

The American Radio Relay League will gladly send a raft of material on AREC organization upon request. *QST* features a monthly column on AREC/RACES activities where you'll find spine-tingling adventures that really happen—stories of hams who have used their stations to evacuate flood victims, order medical supplies from around the world, find lost children, dispatch trains, and answer every imaginable call for help.

From time to time, newspaper headlines announce the name of an amateur or a club who have literally saved lives by knowing

A fully-equipped emergency truck or bus manned by local hams is an asset to any community and may be called on for communication and rescue missions. Shown above is the Ottawa, Illinois, team displaying their generator.

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You Saw It in 73

Francis Wentura, W9AEX, of Quincy, recalls the 1960 Mississippi floods when area hams literally saved the day with patrols along the levees.

what to do in a pinch. You and your club should make it a point to be ready, too.

Clubs on campus

Almost every college has a fine station and a lot of hams on campus, but club officers have to use dynamite to move anyone to a meeting. In the first place, students have little time for leisure activities, and, after all, they're usually in college, for schoolin' not foolin'. Nevertheless, a meeting a month and a ragchew now and then can provide a welcome change of pace for the busiest YL or OM.

As a hint for campus officers, get-togethers should be scheduled when the most folks can attend whether it's 10 A.M. Tuesday morning or 3 P.M. Saturday afternoon. At least one kind of "bait" is a club station licensed members can use for phone patches home and an occasional ragchew just to let off steam. If the equipment is ready to go at all times instead of being dismantled and strewn around the shack, all kinds of fun can be stirred up. Competing with other college clubs on Sweepstakes weekends and for DX contests and Field Days will probably bring in every ham enrolled.

A fixed base station can also spark a campus net or ragchewer's club creating between-meeting interest. Some of the most active young hams ever licensed lose their enthusiasm in radio during college years just because they're completely off the air. Campus radio clubs fight back by seeing to it that members operate at least once in a while. Unless the Dean has a rule on it, transceivers using short whip antennas can be plugged

CLUB SECRETARIES NOTE!

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into a dormitory outlet and fired up for local ragchews or merely "reading the mail."

A campus club takes the spirit of amateur radio plus hard work." Like a lot of other groups, most members are strangers in town, so strive to have a Club-away-from-home-Club.

Officers mustn't be afraid to try something new, and on the spur of the moment. A weekend field trip with portable gear or a CD drill with mobiles patrolling the campus doesn't have to be planned for months in advance. Impromptu parties and activities dreamed up when the work load lightens a bit will strengthen your club and probably call for a repeat later on. The Johns-Hopkins ARC holds an annual beach party they laughingly call an "orgy," and spring picnics are popular, too. A chance to get off-campus for a pre-June Field Day will be a big hit; in fact, just about any chance to get off-campus.

At a small school, the scarcity of hams may be a real snag. But there's an answer to this one, too. Unless you have time to recruit and train novices, take a look around and invite the non-college amateurs who live in the surrounding area. A ham is a ham no matter where he is, and most fellows and gals jump at the chance to visit a new club and become a member. Besides that, opening the campus club to locals can be the beginning of some fine new friendships.

Although we've been talking mostly about co-educational and men's colleges, let's not forget the girls. If you happen to be a licensed YL at Vassar, there's only one way to get gals to take up hamming—QSY your club to where the boys are!

73

Feedback can be either negative or positive, and so can your radio club. So far we've concentrated on ideas and plans your club *should* try, but, needless to say, there are *tabus* to avoid, too. Officers and members alike should work against *cliques* forming within the club; that is, the old time operators sticking together, the novices forming another group, and the technicians staying to themselves. Before long, the groups will start picking at one another and a first-class feud will break out and ruin the club's spirit. Novices can learn from the veterans, and technicians can often bring the 20 year men up to date on new developments. And, although the girls may not appreciate this comment, they should leave the "Have you heard about Helen" remarks at home for the good of the club.

Trying to force some idea on the members that they don't want is asking for trouble. All activities must be something the hams are interested in. A club should be organized around the hams' abilities, and all officers might make a mental note of this opinion. A club can be successful if the officers find out what the members want to do and follow it through regardless of how off-beat it may seem at first.

If your group doesn't seem to favor any particular activity, you can use a free hand in planning. The club which stands still soon disintegrates. Plan plenty of social events, nets, and projects. Take a tip and look over your own club's doings for the last year or so. Has everything been too much on-schedule with picnics held the same month and parties planned at the same place? If so, get out of the rut right now. Better to run the chance of a flop than let the club go stale. Stamp out boredom before it starts.

At the risk of resembling a "do-gooder," club officers should learn a code which isn't made up of dits and dahs. "The Amateur's Code" is a short bit of writing that reminds each ham to be gentlemanly, loyal, progressive, friendly, balanced, and patriotic, too. Anyone who lives up to these goals will be a credit to his hobby, to himself, and most certainly to a radio club.

The answers to such irritating questions as "Can't we do something interesting at our meetings?" and "Why don't we have as much fun as the Up-Hills Club?" may not be found in the Code, but it will sure help you hold your temper while you find it!

And now, although it's a lot easier said than done, Good Clubbing to you and 73!

. . . W5NQQ

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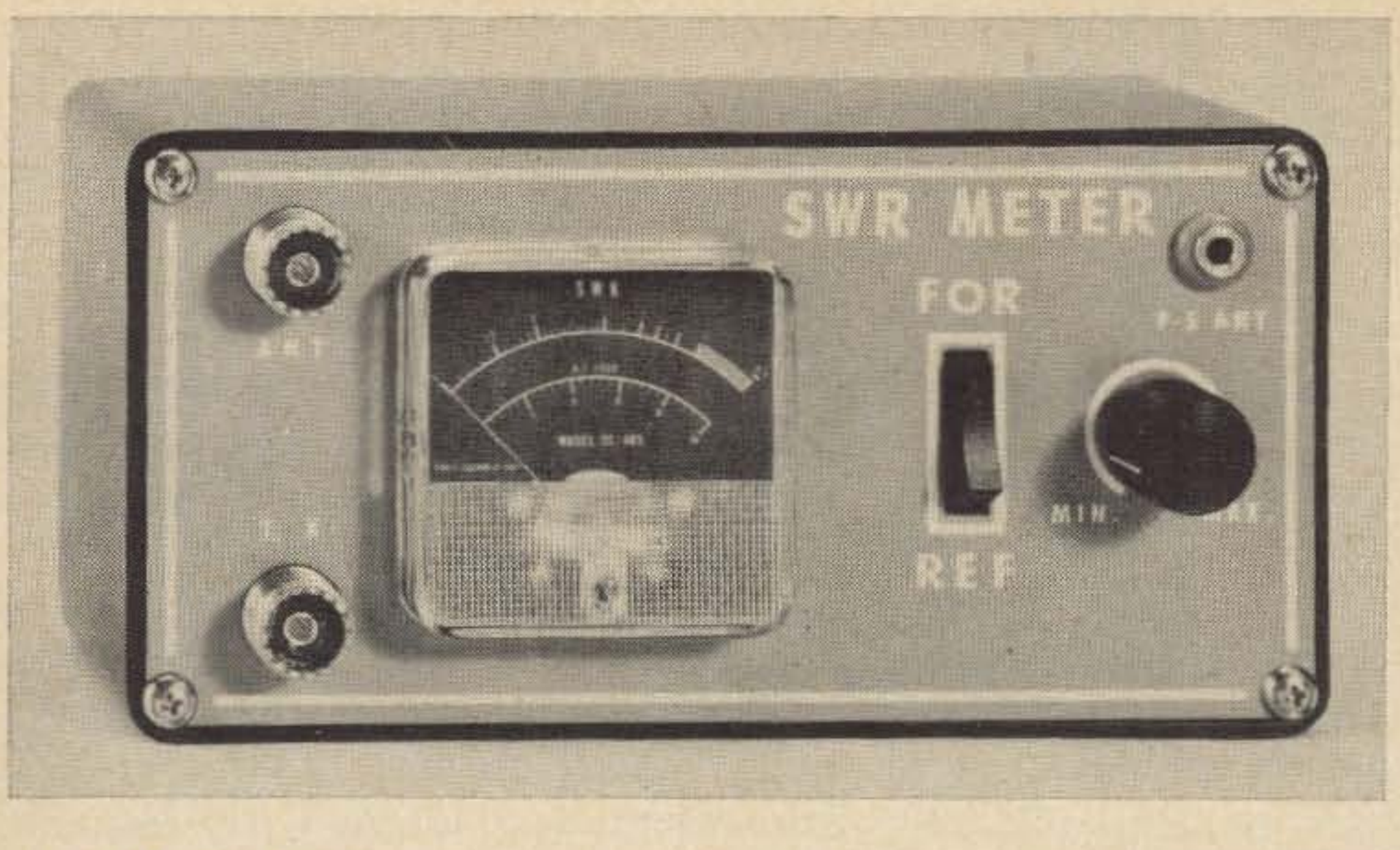

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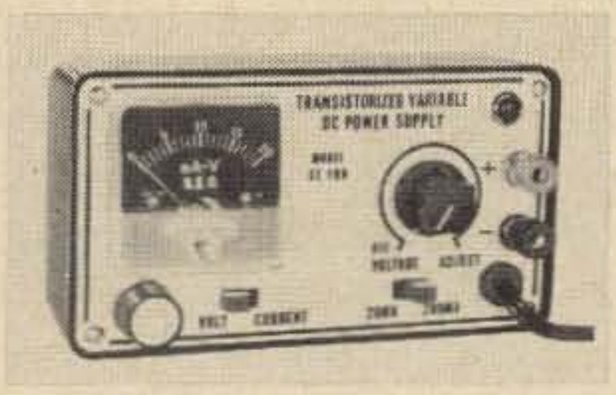

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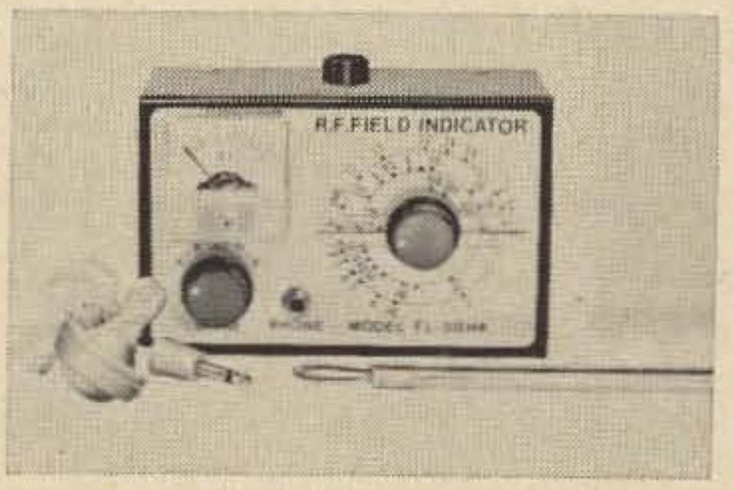

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European VHF

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Except for moonbounce and satelite communications, one rarely hears or reads of the VHF activity on the European continent. I can recall only one or two not-so-recent articles in all of the three major amateur publications. How many even realize that there is really quite a bit of VHF activity—especially on two meters—in all of the eastern and western countries of Europe?

Before I was assigned to Berlin, I held the general misconception that European VHF-ers were few and far between, if they existed at all. I assumed that the two meter band would be as dead as it is in Idaho, where VHF stands for "very high frustrations". I had brought along an SB-34, thinking I'd work lots of DX and keep in touch with stateside. Instead, I spent a whole year with low power trying to squeeze a signal onto the overcrowded HF bands. Erecting a quad only seemed to increase the QRM. During a feeble moment I paid money for a linear and tried to smash holes in the band, but I never did find the Empty Frequency, so all I did was run up the electric bill.

Last summer, during one of the giant weekend contests while trying to get a QSO in edgewise and lengthwise to no avail, I decided to throw in the towel and do something else. Out of desperation I even called a local friend on the landline. Unfortunately, it seems that in Berlin the telephones are so heavily bugged by Us and Them and practically everybody else, that signals are about 30 down in the mud and I could only give him about an S-3 report.

I finally sold out. About two or three months later a friend loaned me an ancient S-38 with a one nuvistor two meter converter. I was surprised at all the activity I found. Besides abundant local signals, on good nights using just a modified three element TV antenna, I logged several nearby countries: SM, OK, SP, and others. Most of the DX was heard on CW, with occasional SSB, and everything else as AM. FM is as rare as a 19¢ hamburger stand over there. Contests are frequent and are quite low key, and are therefore a lot of fun, even for a non-contester like me. There are club bulletins, code practice sessions, and ragchews as long as one wishes. After hearing all this, I was sold. A bit of timely operating with a modest set-up could net about 25 countries, and a lot of local friends during my stay overseas. It got me dreaming of what I could do with a Gonset GSB 2 SSB transceiver and a good 16 element collinear array.

Well, I got the Sidewinder, but it put me so far in the hole money-wise that I've had to settle for a five element bamboo and bent coat-hanger antenna (the BH-2, July '64 in 73). Now we hang our clothes on the floor until I can scare up some more hangers (wooden types this time, insists the XYL).

Since I'm now quite penniless, I begged the wonderful and most understanding wife for two bucks and purchased a keen 20 foot bamboo pole I had spotted at a local grass and flower factory. I then pounded a four inch diameter, five foot long water pipe into the ground and slipped the bamboo pole into the pipe—presto—a hand rotable 20 foot tower. Not really very high, but I wouldn't want to fall that far.

Having worked through my days off pummeling my "sky garage" into some kind of working order and locating it in the stratosphere, I had the thrill of my first VHF contact in Europe from Berlin—to Berlin. Alex, DC7AS, was kind enough to provide me with a critical signal report and even sent a taped recording of our QSO. I should receive more QSL's like that!

Language would be a big problem if it weren't for the fact that nearly all the amateurs of the western European countries use English as their second language. Most have taken it as required curriculum in grade and high schools, and I've found that most of the eastern European hams speak enough English to get by. In any case, it doesn't take very long to pick up enough of the local language (German, in my case) to use for short QSO's. Since I'm the only American ham in Berlin, almost everything I hear on the air is in German. It's no problem though, for as soon as I make a con-

tact the language switches to English. It won't be too long before I become proficient enough in German anyway.

The intention of this article is to help persuade some of the VHF-ers in the States who are coming to Europe, whether for vacation or by military assignment, to bring their equipment along—even just a Two-er—and apply for a license. Most European countries have signed a reciprocal licensing agreement, but it's best to check far in advance to see if it's really happening in the country or countries you wish to visit. VHF mobile is a bonus in Europe—signals are horizontally polarized, so bring a halo. For fixed stations, a four element beam is about the smallest practical antenna. With that, one should be able to work at least a dozen countries from anywhere in Europe. If you are able to work 10 states from your stateside station, you should be able to work at least that many countries over here. Where I am, in Berlin, there are more than 20 countries within range of 20 watts of SSB into a good beam. With aurora and meteors activity during the Fall, the band goes pretty wild!

Don't forget that the European two meter band is only two megs (144 to 146 MHz) wide. If you go rockbound, three crystals will do: 144.01 for CW; 144.5 for AM; and 135.425± 25 kHz for SSB. The last frequency is almost always monitored for any type signal, and is also one of the main DX frequencies.

I'll be here for quite a while to come, so if you ever visit Berlin, be sure to look me up. I've got cold tea, hot coffee, fine German beer, and I'd be glad to loan you my five element coat-hanger. I sure would like to hear some more Americans on two meters in Europe!

. . . DL5QN

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Rambling On —

Jim Ashe W1EZT

If you have constructed a circuit and it doesn't work, maybe there was a mistake in the article. That does happen, and a good exercise before starting anything described in *any* magazine is to read slowly through the schematic looking for a mistake. Here are some examples of mistakes appearing in 73 Magazine.

Vackar VFO

In our October issue, "New Life for an Old Circuit" needs another look. See page 41. Blocking capacitor C9, between R7 and L4, was omitted from the schematic. A value of .01 mfd. will do nicely, but if you are using junk-box parts of uncertain value watch out for a capacitance that resonates with L4 at the operating frequency. A series-resonant circuit here could reflect a heavy load back through Q2 to the collector of Q1, with a possible reduction of stability.

This article also got off without a list of references for further reading. Try these suggestions for more information:

A Stable VFO for VHF or HF, by Del Crowell, 73, Nov. 1966.

The Vackar VFO, A Design and Try, by Gary B. Jordan, Electronic Engineer, Feb. 1968.

New Circuits Concepts for CB Transmitters, Motorola Application Report #84.

RCA Applications Guide ICE-228.

Credit for the original Vackar VFO design used in this article should have gone to Gary B. Jordon.

6 Meter Transmitter

Ken Robbins' article in the Sept. issue could use a bit of touching up. That is the 6-Meter Exciter schematic on page 53. Looking at the 2N3662 crystal oscillator, the 100K resistor extending downward from the transistor base terminal ought to be labeled 10K. The circuit may oscillate at 100K, but with small power output.

And looking at the two MPF105's which serve as a variable frequency oscillator and source follower, we note these are fed through a 330 ohm resistor. The circuit will work as shown, but with degraded stability.

Ken says this point (the junction of the two drain terminals and the 330 ohm resistor) should be held at a fixed voltage with an 8 volt 0.4 watt zener. The zener is bypassed with a 1 mfd. 10 volt capacitor to kill possible zener noise. Careful about polarity—the zener's diode arrow will point at the circuit, rather than at ground.

6 Meter Transceiver

Our September issue contains a nice article on building a solid-state Six Meter Transceiver. But the article was not as nice as it might have been, since it was short the following data on winding up the coils:

L1: 5 turns #26, ¼" long x ⅜" dia; 2 turn link on cold end.

L2: 5 turns #26, ¼" long x ⅜" dia; tap 2 turns from cold end, 2 turn link on cold end.

L3: 6 turns #18, 1" long x ½" dia; tap 1¼ turns from cold end, 2 turn link on cold end.

L4: 10 turns #26, ½" long x ¼" dia; tap 3 turns from cold end, 3 turn link on cold end.

L5: 75 turns #26, 2 layers, ⅜" dia; 3 turn link over middle of outer layer.

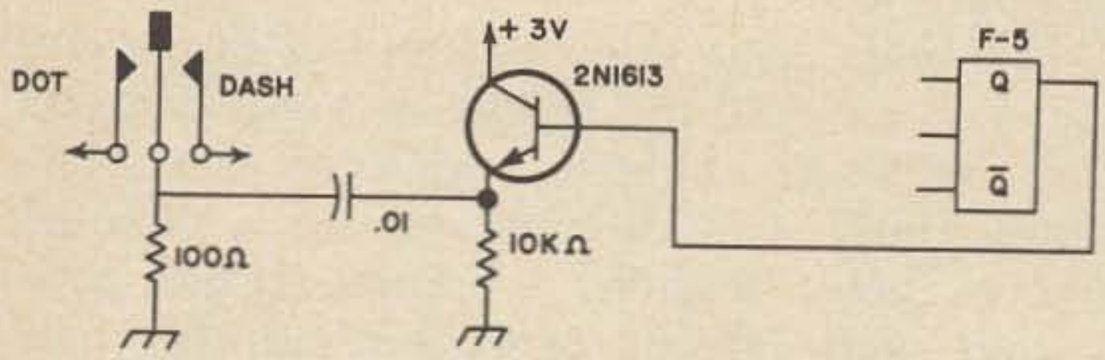
L6: 7 turns #26, ½" long x ¼" dia; tap 3 turns from cold end.

The Micro-Ultimatic

Sometimes we get letters on material printed some time ago, and here is an interesting one. It comes from Glen Winkler, WAØIFV. Glen writes,

"I just finished construction of "The Micro-Ultimatic" (June 1966 p. 6) and am delighted with the results. I etched two double-sided boards and soldered the IC's directly to the boards. Each board is 3½ x 2½ inches and easily holds all components. I have one correction and one suggestion to make. Fig. 7, page 13, should show a connection to "A" instead of "B." I could not achieve the dah-dit-dah-dit-etc pattern with both the dot and dash switches closed. The dot memory, dash memory etc., appeared to operate properly but a series of dashes occured when both the dot and dash switches were closed. The following modification corrected

this difficulty and essentially inhibits the input gates during shift register operation."



Now, do these mistakes have anything in common? Yes, there is an instructive similarity: they aren't subtle mistakes. A missing table, a wrong resistor value, a missing zener diode. Each of these is something visible to a skeptical eye. And a good scrutiny of an unfamiliar circuit is an excellent way to find weak spots in your theory background. Like calisthenics, the exercise tells you where extra work is needed.

Just enough room here for a couple hints to writers. Simple hints. How do you know if 73 would be interested in some idea you are thinking about? Simple. Read the last three issues very closely. There you can see what the editors have been thinking about, and against this perspective you can judge if your own idea might go over, or not. Remember that a part of the life of any magazine is change as well as continuation of present policy, so don't be afraid of new ideas. That's no promise, though. To paraphrase the old woodsman, if you've never had an article bounce you haven't written anything.

. . . W1EZT

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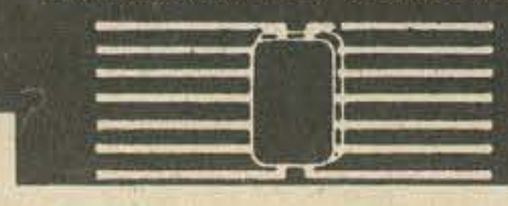

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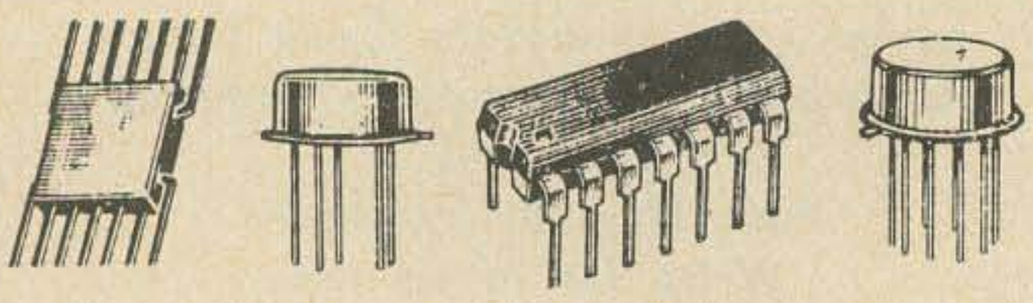

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Note from Meshna:

You have only yourself to blame if you are procrastinating on sending for our 84 page catalog of super-stupendous bargains, the choice of the surplus market, all hand picked by Meshna hisself. With todays shrinking dollar, you want all your shrunken buck will buy. We have a helluva job keeping up with catalog requests now. But we want our mailing dept. to keep sweating and we want you to have an opportunity of selecting the choicest bargains you ever found in the surplus market. Send 25¢ for our latest catalog #69-1 now in preparation. The 25¢ you send does not cover costs but does show a sincere interest on your part. As soon as 69-1 is printed, you'll get one.

JOHN MESHNA JR.
19 ALLERTON ST. LYNN, MASS. 01904

(*W2NSD/1 from pg. 4*)

How about a channel where they can find compatriots?

Car buffs get a great kick out of discussing the new models, the merits of various sports cars, rallying, engines, and even the Mercedes 190D. Couldn't we set up a channel where these blighted creatures could congregate and lament over the sad developments in Detroit?

Our bands are already overcrowded, so where could we possibly put a bunch of new nets? It might be worth while to try 20M since most of the contacts there are two-way at present and the establishment of roundtables would permit many times the occupancy of the frequencies if the stations were netted.

As a starter let's try the following channelation of our interests. Undoubtedly I have neglected to think of a large number of widespread groupings, but let's get started anyway with this and work it from there.

14250	DXing
252	Religious
254	Girls
256	Traveling
258	Hunting-Fishing-Diving
260	Stamps-coins
262	Photography
264	Astronomy
266	Animals
268	Boats
270	Spectator sports
272	Cars
274	Golf-skiing-skating
276	Occult
278	Doctors-lawyers
280	Flying
282	Books
284	Clubs: Masons-Rotary-etc.
286	Boy Scouts
288	Languages
290	Stock Market
292	VFH-moonbounce-scatter
294	CD, RACES, etc.
296	Ham TV, RTTY, FAX, FM
298	Arts: music, painting
14300	UFO Net

The DX'ers should, I suspect, be first. It might just be helpful for DXing to have a channel to check for latest news and QTH's. It is a lot more fun to hook something rare if you have an opportunity to tell the other fellows about it and offer, solicitously, to help them get through as you did.

SCR-SILICON-CONTROL RECTIFIERS!

PRV	16A	25A	PRV	16A	25A
50	.50	.75	400	1.60	1.90
100	.95	1.20	600	1.95	2.75
200	1.15	1.30	800	2.85	3.60
300	1.40	1.65	1000	3.70	4.50

5U4 Silicon Tube ..$1.50@, 5 for $5
5R4 Silicon Tube .....$4@, 3 for $9
866A Silicon Tube ..$10@, 2 for $18

MICA MTG KIT TO36, TO3, TO10, 4/$1
ANODIZED TO36 INSULATOR ....5/$1
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STABISTOR up to Ten Watt, 20 for $1

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PNP 30 Watt/3A, 2N115, 156, 235, 242 254, 255, 256, 257, 301 40c@ ....3 for $1
PNP 2N670/300MW 35c@ .....5 for $1
PNP 2N671/1 Watt 50c@ .....4 for $1
PNP 25W/TO 2N538, 539, 540 ..2 for $1
2N1038 6/$1, 2N1039 .....4 for $1
PNP/TO5 Signal 350MW 25c@, 5 for $1
NPN/TO5 Signal IF, RF, OSC 5 for $1
Finned Heat Sink 180 SQ", $1@, 3/$2
Finned Sink Equiv. 500 SQ". $3@, 2/$5
SILICON PNP/TO5 & TO18 PCKG 2N327A, 332 to 8, 474 to 9, 541 to 3, 935 to 7 & 1276 to 9, 35c@ .....4/$1

866 C.T./2.5V/10A FILAMENT XFMR 10 Ky Insltd $2@, ...3/$5

Bandswitch Ceramic 500W 2P/6Pos, $2@
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** 18	.20	.30	.75	1.00
45	.80	1.20	1.40	1.90
160	1.85	2.90	3.50	4.60
240	3.75	4.75	7.75	10.45

D. C. Amps	400Piv 280Rms	600Piv 420Rms	700Piv 490 Rms	900Piv 630Rms
12	1.20	1.50	1.75	2.50
** 18	1.50	Query	Query	Query
45	2.25	2.70	3.15	4.00
160	5.75	7.50	Query	Query
240	14.40	19.80	23.40	Query

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Line Filter 4.5A@115VAC .... 6 for $1
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Choke 4Hy/0.5A/27Ω $3@ .....4/$10
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PL259A & SO239 CO-AX M&F Pairs 3/$2
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Insltd Binding Posts "EBY" .... 25/$1
Sun-Cells Selenium Asstd ..... 10/$1
Band Pass Filters 60, 90, 150 cys. .3/$3
2.5MH Piwound 500MA Choke .....3/$1
Beam Indicator Selsyns 24VAC ....2/$5
Fuse 250MA/3AG .....50/$1, 300/$2
Oil Cndsr Strobe, Photoflash 25MFD 2000V G.E./Pyranol, $7@ .....2/$10
Resistor Bleeder 50K/100W ....3 for $1

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10 Vct@ 5A & 7.5 Vct @ 5A $5
6.3 Vct 15.5A & 6.3 Vct @ 2A $4
7.5 Vct@ 12A $3@ ..... 2/$5

We have around the world quite a number of missionaries and padres who are active on our bands. I know that they particularly enjoy being able to contact each other and a channel on 252 should help them out. Of course the DXers in the next channel will keep their ear peeled for some of the rarer ones such as 9N1MM and 9X5GG.

Frankly I am not at all sure what can be discussed as far as girls are concerned, but I do know that they are of great interest to many amateurs and every time I have proposed this channel idea to a radio club there has been a demand for a girl channel. So be it.

If you have any interest of your own that doesn't seem to fit the list and which you feel should be represented, drop a line and we'll try and set up a special time or day for it on one of the channels that seems to have less activity than the others.

Let's give this a try and see if it develops into anything of value. Dissidents can get together on 14302 and coordinate.

. . . Wayne

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40 watt germenium power transistor, same as Delco 501, 2N278 (etc), Cat: 349, 59¢ each.

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Motorola 2500 ma. at 1000 piv, high voltage/current epoxy silicon rectifier, axial leads. Cat: HEP-170, 49¢ ea.

2 Printed circuit I.F. transformers, 4 lug, 455 kc input and output, Cat: 1909P4, 99¢ each.

RCA UHF transistor type TV tuners, KRK-120 (long-shaft) cat: UHF-20; KRK-120 (short shaft) cat: UHF-21, each $4.98.

RCA VHF transistor type TV tuners, KRK-146, cat. VHF-74, $9.99 each.

Transistorized U.H.F. tuners used in 1965 to 1967 TV sets made by Admiral, RCA, Motorola, etc. Removable gearing may vary from one make to another. Need only 12 volts dc to function. No filament voltage needed. Easy replacement units. Cat: UHF-567, $4.95.

U.H.F. Tuner original units as used in TV sets such as RCA, Admiral, etc., covering channels 14 through 82, as part no. 94D173-2. Complete with tube. Drive gearing is removable. Can be used in most sets. Cat: UHF-3, $4.95.

Color yokes. 70° for all around color CRT's. Cat: XRC 70, $12.95. 90° for all rectangular 19 to 25" color CRT's, Cat: XRC-90, $12.95.

Kit of 30 tested germanium diodes. Cat: 100, 99¢.

Silicon rectifier, octal based replacement for 5AS4-5AW4-5U4-5Y3-5T4-5V4-5Z4. With diagram. Cat: Rect-1, 99¢ ea.

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Tube cartons 6AU6 etc., size, $2.15 per 100. 6SN7 etc., size $2.55 per 100. 5U4GB size $2.95 per 100. 5U4G size $.03 each.

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502-22nd St., Union City, N.J. 07087 Dept. 73
Phone: 201-UN 4-5568

Letters

Dear 73,

Kagnew Station Amateur Radio Club (ET3USA) is a small club—mostly military personnel—with a very limited treasury. At present we can barely afford the cost of printing QSLs and mailing logs to our QSL manager, plus the other costs necessary to keep the club going.

We regret we must ask for S.A.S.E. or IRC from all hams desiring QSLs. Please do not QSL direct to us. VE3TG has all logs and QSL cards.

We are trying to keep the station on the air as much as possible despite difficulties. All equipment here is owned by individuals and it looks as if we'll lose the beam we're using when the owner returns to the States in December.

ET3USA—Mrs. Deane Lindsay
W4EJQ—Secretary

Dear Wayne,

I just received my November issue of 73. I'd like to offer my compliments to you and your staff for an excellent cover. I don't know who your art makeup person is, but you're not paying him (or her) enough. The October cover was also just great. Please accept my congratulations.

I read your column "de W2NSD/1." You ask that anyone hearing "self righteous policement" to tell them that "Wayne Green says that he is sick and needs immediate mental treatment . . . "

I am so sorry to hear that you are suffering from some kind of mental illness problem. Would you please accept the enclosed dollar? I sincerely hope it will help toward your rapid recovery, because I hate to see anyone suffer.

A. Wilson W6NIF
San Diego, Calif.

Thanks a meg for the dollar. I took it right down to the local psychiatrist and invested in two minutes of intensive first class therapy. You will be happy to know that I have been pronounced completely cured and that all the thanks goes to you. Wayne.

Dear Madame,

Following the publication of my article "Burn Prevention" in the July issue of 73, I had several inquiries about the German soldering pistol pictured therein. The pistol, called the Sprint, is made by Europe's foremost manufacturer of soldering equipment, ERSA Ernst Sachs K.G., 6980 Wertheim am Main, Postfach 66, West Germany. The unit, because it does not use a conventional transformer as in other fast-heating irons, weighs less than half a pound and still heats up to about 100 watts in 10 seconds. Cost is about $8 plus postage.

D. E. Hausman VE3BUE
Ontario, Canada

Dear 73,

Your very good Advanced Class study guide articles are wonderful. Well written in common sense terms. The writer is easy to understand. I've read a lot of radio articles, but these are just great. Thanks much.

E. Schaldack WA9QQV
Chicago, Ill.

To the 73 Gang,

Just so my conscience is free and I get a good night's sleep, I felt obligated to write you regarding the fine magazine. Some time ago, I thought I'd drop the thing. Then you started the Advance Class License Course, which is, by itself, worth the price of the magazine. I like the "Editorial Liberties" by Kayla . . . if there is something outstanding about the publication, it is the "personal" feeling as though you were among friends. Best wishes for continued success.

C. E. Shaffer WA9VRK
Plymouth, Indiana

These are just two of the hundreds of letters which have come from readers in response to the study course. The Advanced course will be completed with this issue. We will immediately have it put in book form. Beginning with the February issue, we begin the Extra preparation.

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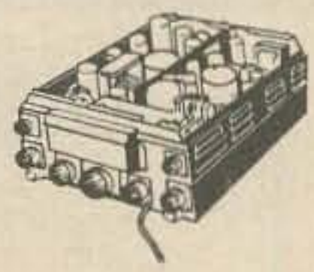

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7-9.1 Mc.	BC-459	$17.95	$22.50
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★ Deadline for ads is the 1st of the month two months prior to publication. For example: January 1st is the deadline for the March issue which will be mailed on the 10th of February.

★ Type copy. Phrase and punctuate exactly as you wish it to appear. No all-capital ads.

★ We will be the judge of suitability of ads. Our responsibility for errors extends only to printing a correct ad in a later issue.

★ For $1 extra we can maintain a reply box for you.

★ We cannot check into each advertiser, so Caveat Emptor . . .

HAM AUCTION, Feb. 16, 14th Annual by Toledo Mobile Radio Ass'n, at the Lucas County Recreation Center, 2901 Key St., Maumee, Ohio. $1.00 Registration, open table sales, map and further info. write Ron W8STA, 1939 Cone, Toledo, Ohio 43606.

WANTED: Opportunity to quote your needs. 30 years a ham dealer. Collins, Drake, Swan, all others. $20,000.00 inventory used gear. Electronic Distributors, 1960 Peck, Muskegon, Michigan 49441.

TEST EQUIPMENT WANTED: Any equipment made by Hewlett-Packard, Tektronix, General Radio, Stoddart, Measurements, Boonton. Also military types with URM-( ), TS-( ), SG-( ) and similar nomenclatures. Waveguide and coaxial components also needed. Please send accurate description of what you have to sell and its condition to Tucker Electronics Company, Box 1050, Garland, TX. 75040.

ESTATE LIQUIDATION SALE: Johnson Invader with Johnson low loss filter, $75.00; Heath HW-30 with microphone and instruction, $30.00; Heath IM-11 VTVM, $30.00; Heath IT-12 signal tracer, $15.00; RCA Voltohmyst Model WA65A (battery), $25.00; Waters Protax model 335 coax switch, $8.00; Barker-Williamson model 350 coax switch, $5.00; Signal Corps Bug key type J-36, $8.00; (4) new Eimax 7203/4CX250B tubes, $20.00 each; Ameco VHF model CN converter with model PS-1 power supply, $25.00. Arthur W. Lee, Rte #1, Box 23A, North Monmouth, Maine 04265. Tel: 207-933-2869.

SELL: SX-130 still in original box, won at a hamfest. Best offer over $125.00. Tom Hentz, WA9MCB, Room 326, Thomas Jefferson Hall, Rolla, Mo. 65401.

HEATH GC1-A receiver, XP-2 supply. $75. Heath HW-30 two meter transceiver, $35. Both with manuals. You pay shipping. W8ICY, 639 Lake Ave., Ironwood, Mich. 49938.

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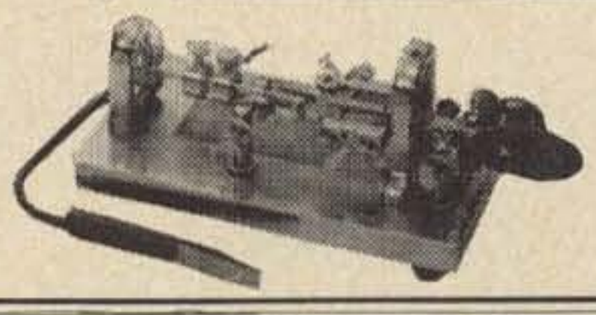

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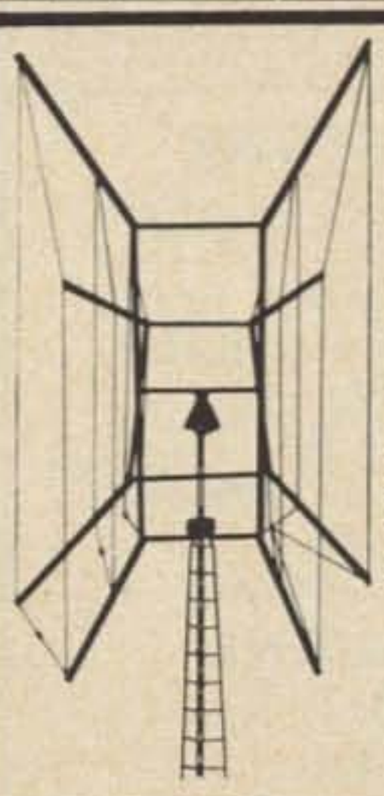

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WANTED: Back issues of 73 Magazine, November 1960 through March 1961. C. W. Janes K2KS, 2 Windsor Gate, Upper Saddle River, N.J.

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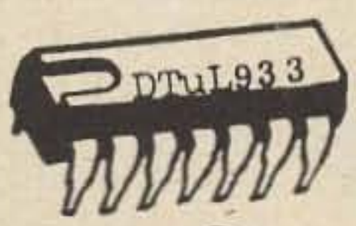

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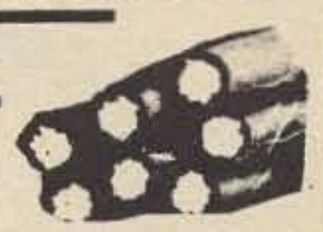

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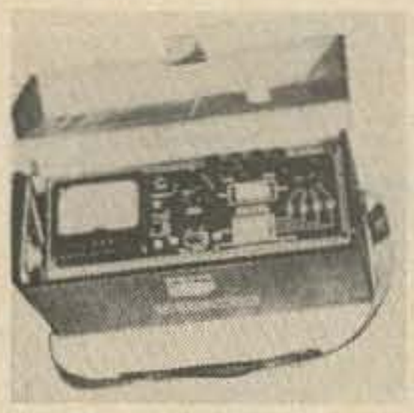

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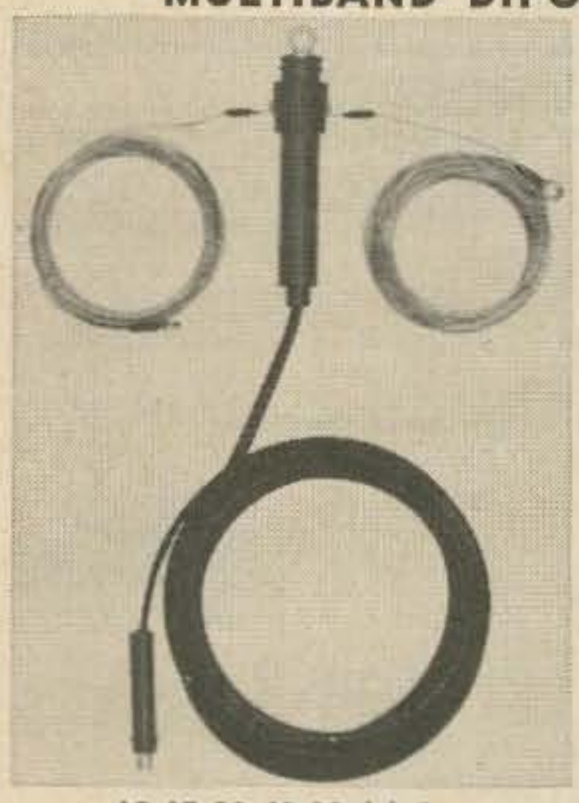

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Monte Carmelo (MG) Brazil

"A very F.B. piece of equipment. Audio very nice, especially on SSB, which is rare."

Thomas F. Totten, Jr. WB2GZR
Saratoga Springs, N. Y.

"Running it with a Mosley "Classic" beam and proves a most fine and nice transceiver. Really proud of it."

Orlando Escudero O., CE-3-OE
Santiago, Chile

"Looks good—sounds good—very well pleased with performance."

Wayne M. Sorenson, WAØETL
St. Paul, Minn.

"Have had Drake 2-B for three years. Knew that TR-4 was same Good Stuff."

Charles E. Bishop, WA8FTT
Columbus, Ohio

"Just what I always wanted."

Daniel N. Hamilton, WA4WXQ
Ashland, Va.

"Why not build a good 6 Meter SSB & AM Transceiver . . . hurry up, I'm waiting."

Harold A. Zick, WA9IPZ
Creve Coeur, Ill.

"Excellent equipment."

W. T. Newell, WB6UZU
Palm Springs, Calif.

"O.K. 100 x 100. RV-4: O.K./W-4: O.K./ L-4: O.K. Very Good!"

Franscisco Fau Campmany, TI-2-FAU
San Jose de Costa Rica

"A beautiful piece of equipment. My second piece of Drake. The first was a 2-B and this sold one friend an R-4 receiver and another a TR-4. We are Drake-minded here in town. Many thanks."

Charles E. Boschen Jr., WA4WXR
Ashland, Va.

"I'm sure this, like the other Drake equipment I have, is the finest money can buy. YOU MAY QUOTE ME ON THAT."

C. E. (Ed) Duncan, WA4BRU
Greenville, S. C.

"I'm a real happy man with it. Does a real good job of getting thru."

Jerome D. Lasher, W2RHL
Hamburg, N. Y.

"Replaces my TR-3."

D. G. Reekie, VE 6 AFS
Calgary Alberta Canada

"Finest performing gear I have ever had the pleasure of operating."

Milton C. Carter, W2TRF
Lakewood, N. J.

"PS Several months have passed . . . I now employ TR-4 as mobile unit and base station. I have logged more than 1000 contacts, many being rare DX. I am looking forward to owning a second unit to be used strictly for mobile. To date TR-4 has been trouble-free."

Milton C. Carter, W2TRF
Lakewood, N. J.

"Well pleased."

Rev. James Mohn, W3CKD
Lititz, Pa.

"I am delighted with Drake gear. This is the second of your transceivers for me. I have used a TR-3 in my car for about 2½ years—only trouble: replacing a fuse!"

Guy N. Woods, WA4KCN
Memphis, Tenn.

"Ask the ham who owns a Drake TR-4"

. . . or write for details . . .

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